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ATTRIBUTE SPACE DEVELOPMENT AND EVALUATION

Dr. Peter G. Ossorio

Linguistic Research Institute
and
University of Colorado

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AFLC, GAFB, N.Y., 19 Feb 68-104

FOREWORD

This final report was prepared by Dr. Peter G. Assorio of Linguistic Research Institute, Boulder, Colorado under Contract AF30(602)-4032, Project 4594, Task 459401. Mr. Robert N. Ruberti (EMIIH) was the Rome Air Development Center project engineer.

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This technical report has been reviewed and is approved.

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ABSTRACT

Evaluation of automatic indexing and retrieval effectiveness of the Classification Space and the Attribute Space procedures was carried out with a set of actual users and requests. A "rule-following model" of language and behavior was presented as a basis for an integrated program of research and development in linguistic data processing. Three feasibility studies directed toward the technical implementation of Means-Ends, Process-Activity, and Part-Whole concepts as information formats were performed.

EVALUATION

Sections 1-3 of this report discuss the effectiveness of two indexing and retrieval procedures designated as a Classification Space and Attribute Space. Each procedure was tested separately and jointly in an operational setting. Separately, each showed a significant degree of effectiveness over a keyword approach. Jointly, the combined models showed an improvement over the use of either one by itself.

A brief but good critique of existing approaches to linguistic data processing is given in section 4, and a new approach for research and development in this field is presented.

Section 5 discusses additional ways of formatting textual information in terms of mean-ends, part-whole and process-activity relationships.

Robert N Ruberti

ROBERT N. RUBERTI
Project Engineer

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1.0 Introduction

The research described in the present report is an extension of previous work presented in RADC-TDR-64-287 and RADC-TR-65-314.

In the former report the Classification Space procedure was introduced and empirically validated as an indexing system for an information storage and retrieval system. Briefly, the Classification Space is an N-dimensional Euclidean space with a coordinate system in which the reference axes are interpreted as subject-matter dimensions. Words, sentences, documents, and other textual units are assigned point-locations in the space and the projections of each point on the reference axes are interpreted as the degree of relevance of that textual unit to that subject matter dimension. Retrieval in an implemented Classification Space is accomplished by indexing the retrieval request as a point-location in the Classification Space and computing the distance from this point to the point-locations of textual units already indexed within the space. Since the distance from the location of a given textual unit to the location of the retrieval request is interpretable as the degree of subject matter relevance of that textual unit to that request,

the retrieval of textual units is performed in accordance with the rank order of these distances.

The principal technical achievement reported in RADC-TDR-64-287 was the demonstration of techniques for the construction of a Classification Space and for its implementation as a functioning information storage and retrieval system. The principal empirical demonstration was that distances in a Classification Space can in fact, within some weak limitations, be interpreted as subject matter relevance for retrieval purposes.

It was indicated in RADC-TDR-64-287 that the information requirements of users can only rarely be formulated as a simple subject matter request. That is to say that even if flawlessly complete and accurate subject matter indexing were available, a user would not, in general, be able to identify uniquely and differentially the information he wanted by means of a subject matter description. Thus, the problem of information storage and retrieval in the field of linguistic data processing was seen to be the problem of implementing some finite number of general forms of information description, with subject matter being merely one such form.

The work reported in RADC-TR-65-314 represented a

further attack on the LDP problem as formulated above. In this project a second general form of information description was developed. This form was that of a "conceptual content" description; i.e., a description in terms of the meaning components of the words in which the information could be couched. The technical implementation was the construction of an "Attribute Space" in which the reference axes are interpretable as components of meaning and words, phrases, etc., are assigned to point locations in the Attribute Space on the basis of their meanings. The distance between two items located in the Attribute Space is proportional to their degree of similarity in meaning.

In the present report, Section 2 is concerned with the results of a retrieval study employing the Classification Space procedures. In contrast to the earlier Classification Space study, the present study deals with Users in a real life setting. In Section 3, a report is given of a retrieval study employing the Attribute Space procedures. This study parallels the Classification Space study reported in Section 2 and involves the same Users and retrieval requests. A comparison is made of the C-Space and A-Space retrieval, and a procedure for using both resources jointly is empirically illustrated. Section 4,

augmented by Appendix P and Appendix Q, contains a basic and general statement of a rationale for a program of research and development in the domain of linguistic data processing. In addition to the conceptual formulation, an articulated program of research involving specific projects and an overall schema for a new generation of linguistic data processing systems is presented in this section. Section 5 deals with the results of several feasibility studies directed toward the future implementation of other basic forms of information description in addition to the subject matter and conceptual content descriptions which are currently within the state of the art. Although the exploratory study of the new forms was originally undertaken as an extension of the Attribute Space and Classification Space methodology, an effort is made to interpret these studies in the light of the conceptualization and program presented in Section 4.

2.0 Classification Space Retrieval In An Operational Setting

The present study represents an effort (a) to establish a gross level of success for the Classification Space procedure when the initial experimental procedures are applied relatively unchanged in an operational setting, (b) to identify problems stemming from the difference between operational and experimental settings, and (c) to provide the basis for comparison with the Attribute Space procedures in the same setting and suggest ways in which the two procedures might be most effectively combined.

The Classification Space Retrieval Study (also referred to hereafter as the CSR Study) comprised the following.

(a) The construction of a Classification Space covering a subject matter domain relevant to a set of users.

(b) The indexing of a system vocabulary and a set of 188 documents in the Classification Space.

(c) The processing of eleven retrieval requests made by six users and an evaluation of the level of success of the retrieval procedure.

Each of these aspects is reported in greater detail below.

2.1 Construction of the Classification Space

The domain for the Classification Space is defined by the list of twenty-three subject matter fields shown in Table 2.1A. These fields were chosen on the basis of consultation with a set of users consisting of professional personnel in various departments at RADC. (The "users" referred to in connection with various phases of the C-Space study and the A-Space study are the same group of individuals generally, though not every user participated in every phase of these studies.) The original list of fields representing user interest was pared down to a smaller list for which the standard minimum of three C-Space judges could be anticipated.

For each of these fields one or more user who specified that field as falling within his scope of professional interest identified six documents as definitely belonging to that subject matter field. In addition, he specified three or more words as being distinctively associated with that field. From the six documents, twelve technical terms were chosen by a quasi-random process. Thus, for the purposes of Classification Space construction, each field was represented by fifteen terms; i.e., twelve terms taken from the literature and three 'distinctive' terms. Terms for all of the fields were combined into a single "C-Space List".

For each field, one or more persons competent in that field were selected as judges. Approximately forty percent of the judges were advanced graduate students at Syracuse University. The remaining judges were approximately equally divided between RADC personnel and a group consisting of USBS personnel and University of Colorado graduate students. The number of C-Space judges for each field is shown in Table 2.1A in the first parenthesis following the name of the field. (The second parenthesis gives the number of A-Space judges.) As shown in this table, five of the twenty-three fields are represented by fewer than the three judges which previous work suggests as a working minimum. However, it appeared that failure to include the five under-represented fields would substantially compromise the retrieval capability of the resultant Classification Space. As in previous C-Space studies, therefore, the present study reflects substantially less than optional experimental conditions, and the results are, in that respect, conservative rather than inflated.

Each of the judges made relevance ratings of each item on the C-Space List in relation to his field of competence. Ratings by the several judges were averaged to give a word-by-field data matrix. Using this data matrix, the twenty-three

fields were intercorrelated. In turn the correlation matrix was factored by the Minimum Residual method and rotated to a Varimax criterion. These factor results showed eight interpretable and measurable common factors. These, together with nine "unique" factors are summarized in Table 2.1B. In this table, the first eight factors are the common factors. The factor space defined by the seventeen factors shown in Table 2.1B is the Classification Space used in the retrieval study.

Table 2.1A Classification Space Fields

1.	Adaptive Systems	(4)	(4)
2.	Analogue Computers	(3)	(2)
3.	Applied Mathematics	(6)	(5)
4.	Automata Theory	(4)	(4)
5.	Computer Components and Circuits	(4)	(4)
6.	Computer Memories	(1)	(1)
7.	Computer Software	(7)	(5)
8.	Display Consoles	(2)	(2)
9.	Human Factors	(2)	(3)
10.	Information Retrieval	(4)	(5)
11.	Information Theory	(3)	(3)
12.	Input - Output Equipment	(5)	(5)
13.	Language Translation	(3)	(3)
14.	Linear Algebra	(7)	(6)
15.	Multivariate Statistical Analysis	(4)	(4)
16.	Non-Numeric Data Processing	(5)	(5)
17.	Numerical Analysis	(6)	(7)
18.	Pattern Recognition	(3)	(3)
19.	Probability and Statistics	(4)	(4)
20.	Programming Languages	(8)	(7)
21.	Stochastic Processes	(4)	(4)

Table 2.1A Classification Space Fields (Continued)

22.	System Design and Evaluation	(2) (2)
23.	Time-Sharing Systems	(2) (2)

Table 2.1B The Classification Space

Factor 1	
.845	Stochastic Processes
.843	Probability and Statistics
.760	Multivariate Statistical Analysis
.639	Information Theory
.623	Applied Mathematics
Factor 2	
.923	Computer Software
.861	Programming Languages
.639	Time-Sharing Systems
.624	Human Factors
Factor 3	
.793	Computer Components and Circuits
.619	Computer Memories
Factor 4	
.758	Adaptive Systems
.687	Pattern Recognition
Factor 5	
.792	Numerical Analysis

Table 2.1B The Classification Space (Continued)

Factor 5 (Continued)	
.771	Linear Algebra
.692	Applied Mathematics
Factor 6	
.719	Information Retrieval
.656	Language Translation
.648	Non-Numeric Data Processing
Factor 7	
.621	Display Consoles
.580	Input - Output Equipment
Factor 8	
.726	Analogue Computers
Factor 9	
.950	Automata Theory
Factor 10	
.750	Computer Memories
Factor 11	
.728	Display Consoles

Table 2.1B The Classification Space (Continued)

Factor 12	
.640	Human Factors
Factor 13	
.640	Information Retrieval
Factor 14	
.645	Information Theory
Factor 15	
.632	Input - Output Equipment
Factor 16	
.640	Numerical Analysis
Factor 17	
.600	Linear Algebra

2.2 System Vocabulary and Document Indexing

Eight users selected 94 documents from recent journal sources as being relevant to their general professional interests. In addition, 94 recent dissertation abstracts were selected as giving roughly comparable content coverage. From the journal sources, additional technical expressions were selected for the system vocabulary, in such a way as to ensure that each journal source was represented in the system vocabulary by at least five terms. These terms, together with the C-Space List comprised the system vocabulary. When duplications between the two sources of terms were eliminated, the total number of terms in the system vocabulary was 1125.

Each of the terms in the system vocabulary was rated by the C-Space judges in regard to the degree of relevance of each term to the field of competence of the judge (instructions and rating format being the same as described for the C-Space in RADC-TDR-64-287). The collection of data for the C-Space construction and for the system vocabulary was accomplished with a single experimental rating procedure.

By means of the C-Space delineated in Table 2.1B and the third-power weighted-average formula presented in RADC-TDR-64-287, the judges' average ratings of the system vocabulary

terms were transformed into Classification Space coordinates for these terms. The assignment of these coordinates to a given term is what qualifies that term to function as a part of the system vocabulary.

The 188 documents were prepared in computer-readable form. The dissertation abstracts were carried in their entirety and the remaining documents were represented by some representative portion, usually several paragraphs long. All documents were then automatically indexed in the Classification Space by means of the Classification Formula described in RADC-TDR-64-287. The Classification Formula assigns coordinates to a document as a function of the coordinates of the system vocabulary terms which appear in the document.

2.3 The Classification Space Retrieval Experiment

Users were instructed to prepare three Information Requests. These instructions, together with sample requests obtained from the earliest users, are presented in Appendix A. It should be noted that both the instructions and the requests which were formulated represent a gross departure from simple subject-matter specification and instead more nearly constitute a direct portrayal of the need for information. In point of fact, as will be seen below, the departure was sufficient to indicate the advisability of a modified quantitative analysis.

Eleven requests, identified as requests A through K in Appendix C, were formulated by six users. For each request, the user made a yes - no choice for each of the 188 documents indexed by the system and selected some number of documents which he regarded as acceptably relevant to his request. Each request was prepared in computer - readable form and indexed in the C-Space. For each request, retrieval of documents indexed in the C-Space was accomplished by ranking the documents in the order of their C-Space distance from the index (location) of the request. Since no quantitative or distance limitations were set, all 188 documents were retrieved for each request. Thus, for each request, each document received a number representing its

rank-order relevance to the request.

The evaluation of the level of success of the Information Request processing would appear to be most naturally accomplished by calculating the mean or median rank (in the automatic retrieval sequence) of those documents which were identified as relevant to the request by the user making the request, and further, calculating the probability level of obtaining that mean rank on a random basis.

This is substantially the analysis which was made. The results of exactly this analysis are shown in Table 2.3A. However, because several of the requests appeared on examination, to consist of several relatively independent requests, it seemed most advisable to treat them as separate requests for retrieval purposes.

Unfortunately, most of the users were no longer available for selecting relevant documents in terms of the new requests. Thus, for example, Request A was considered to be a composite of three requests; i.e., Request 1, Request 2, and Request 3. However, whereas the selection of documents relevant to Request A was available, no corresponding selection of documents relevant to Request 1 as against Request 2 as against

Request 3 was available. Under these conditions, the most informative analysis appeared to be one in which the documents relevant to Request A were ranked separately with respect to Requests 1, 2, and 3 and the (numerically) lowest of these rankings for each relevant document selected. Such a procedure corresponds to the informally expressed notion that any document which was relevant to Request A was primarily relevant to <u>either</u> Request 1 <u>or</u> Request 2 <u>or</u> Request 3, and that which of these it was is best estimated by seeing where among the three the document obtained the lowest rank.

Thus, Requests A through K were reformulated as Requests 1 through 18. The correspondences are given in Appendix C. Requests 1 through 18 are shown verbatim in Appendix B. With each request is shown the system vocabulary terms which appear in the request and which were used in indexing the request automatically for retrieval purposes.

The results of the analysis of the automatic processing of Requests 1 through 18 are shown in Table 2.3B. A comparison of the retrieval rankings under the reformulation (Requests 1-18) as contrasted with the original formulation (Requests A-K) is shown in Table 2.3C. These results show that the reformulation provided a substantial improvement in retrieval effectiveness,

so that on the average, a relevant document was retrieved in one-half the number of trials in the reformulated requests as against the original requests.

It should be noted that the retrieval rank of a relevant document is not independent of the retrieval ranks of other documents relevant to the same request. The mean retrieval rank for the documents relevant to a given request will have a lower bound equal to (n + 1.0)/2.0, where n is the number of relevant documents. For example, since there were sixteen documents relevant to Request F, even under ideal retrieval; i.e., if these were the first sixteen documents retrieved, the mean retrieval rank for these sixteen documents would be 8.50. Thus, the data shown in Tables 2.3A-B-C are not to be interpreted with the notion that perfect retrieval would correspond to a mean retrieval rank of 1.0. In this connection, the data shown in Table 2.3D is perhaps more revealing. Table 2.3D shows that, overall, more than half of the documents relevant to a request are retrieved within the first ten trials (documents) and that roughly three quarters are retrieved within the first twenty trials. These results are nearly identical, overall, for the C-Space retrieval and the A-Space retrieval.

By inspection, it is clear that the results summarized

in Tables 2.3A-B-C-D represent a level of statistical significance considerably beyond the traditional .01 level, and so statistical tests were not performed. Such results are to be expected for any retrieval technique which even remotely approaches operational adequacy, since, after all, the goal of any retrieval technique is perfect retrieval, not merely results which can with some confidence be declared better than chance.

Table 2.3B shows the results of keyword retrieval operating on Requests A-K. For this purpose, the system vocabulary terms which occurred in a given request were used as keywords for that request. Documents in which any keyword occurred were retrieved. Inspection of Table 2.3B shows that of the 62 documents relevant to the eleven requests, 40 were retrieved. A total of 226 documents were retrieved in response to the eleven requests, making an average of 5.65 documents retrieved for each relevant document retrieved. Comparable figures for retrieval of <u>all</u> 62 relevant documents are 6.72 for the C-Space and 6.99 for the A-Space.

A summary of distances from relevant documents to requests in both C-Space and A-Space is given in Appendix E. These and other results involving both C-Space and A-Space are discussed in Section 3.

Table 2.3A Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K As Formulated By Users

Request	Relevant Document	C-Space Rank	A-Space Rank
A	55	24	44
	68	4	25
	76	53	56
	105	33	39
	106	14	57
	107	15	29
	108	52	103
	109	8	10
	110	123	68
	Mean Rank	36.2	47.9
	Median Rank	19.5	42.5
B	111	28	8
	187	27	10
	112	10	2
	113	64	3
	Mean Rank	27.5	5.7
	Median Rank	27.5	5.5

Table 2.3A Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K As Formulated By Users (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank
C	14	2	4
	22	9	5
	77	50	13
	102	13	44
	Mean Rank	18.5	16.5
	Median Rank	11	9
D	21	27	98
	25	19	57
	27	51	118
	103	36	3
	104	98	4
	Mean Rank	46.2	56.0
	Median Rank	31.5	30.5

Table 2.3A Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K As Formulated By Users (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank
E	49	2	65
	136	51	31
	137	49	41
	138	62	70
	139	43	24
	140	16	11
	141	10	13
	Mean Rank	33.3	36.4
	Median Rank	29.5	27.5

Table 2.3A Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K As Formulated By Users (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank
F	1	4	3
	46	18	13
	47	29	64
	48	7	10
	142	9	51
	143	20	15
	144	5	2
	145	19	8
	146	1	20
	147	3	9
	148	12	6
	149	8	7
	150	35	24
	151	25	26
	152	41	27
	153	28	28
	Mean Rank	17.1	18.9
	Median Rank	15.0	14.0

Table 2.3A Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K As Formulated By Users (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank
G	71	11	19
	79	13	27
	84	9	30
	164	8	6
	165	12	3
	166	6	1
	Mean Rank	10.8	14.5
	Median Rank	10.0	13.5
H	167	13	46
	168	5	31
	169	1	24
	170	3	5
	Mean Rank	5.5	26.5
	Median Rank	4.0	27.5
I	171	4	10

Table 2.3A Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K As Formulated By Users (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank
J	114	5	4
	115	14	1
	Mean Rank	9.50	2.50
	Median Rank	9.50	2.50
K	172	70	12
	173	1	2
	174	10	5
	175	24	22
	Mean Rank	26.25	10.25
	Median Rank	17.0	8.50

Table 2.3B Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K When Processed As Requests 1-18

Request	Relevant Document	C-Space Rank	A-Space Rank	Keyword Retrieval
A	55	3	29	0
(1,2,3)	68	2	27	0
	76	20	43	0
	105	2	1	Hit
	106	6	5	Hit
	107	3	2	0
	108	20	4	0
	109	1	1	Hit
	110	40	22	0
	Mean Rank	10.6	15.0	6 False Neg
	Median Rank	3.0	4.5	14 False Pos
B	111	28	8	Hit
(4,5)	187	27	10	Hit
	112	10	2	Hit
	113	64	3	Hit
	Mean Rank	27.5	5.75	0 False Neg
	Median Rank	27.5	5.5	11 False Pos

Table 2.3B Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K When Processed As Requests 1-18 (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank	Keyword Retrieval
C	14	1	9	Hit
(6,7)	22	2	4	Hit
	77	37	32	0
	102	5	8	Hit
	Mean Rank	11.25	13.25	1 False Neg
	Median Rank	3.5	8.5	23 False Pos
D	21	16	24	0
(8,9)	25	5	8	0
	27	24	90	Hit
	103	10	2	0
	104	70	14	0
	Mean Rank	25	27.6	4 False Neg
	Median Rank	13	11	22 False Pos

Table 2.3B Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K When Processed As Requests 1-18 (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank	Keyword Retrieval
E	49	2	65	Hit
(10)	136	51	31	0
	137	49	41	0
	138	72	70	Hit
	139	43	24	Hit
	140	16	11	Hit
	141	10	13	Hit
	Mean Rank	34.6	36.4	2 False Neg
	Median Rank	29.5	27.5	9 False Pos

Table 2.3B Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K When Processed As Requests 1-18 (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank	Keyword Retrieval
F	1	2	3	0
(11,12,13)	46	8	13	Hit
	47	26	66	Hit
	48	9	9	Hit
	142	8	44	0
	143	17	7	0
	144	3	1	Hit
	145	17	8	Hit
	146	1	15	Hit
	147	1	2	Hit
	148	6	4	Hit
	149	9	7	0
	150	23	9	0
	151	17	18	Hit
	152	34	21	Hit
	153	23	14	Hit
	Mean Rank	12.5	15.0	5 False Neg
	Median Rank	8.5	8.5	8 False Pos

Table 2.3B Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K When Processed As Requests 1-18 (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank	Keyword Retrieval
G	71	11	19	Hit
(14)	79	13	27	Hit
	84	9	30	Hit
	164	8	6	Hit
	165	12	3	Hit
	166	6	1	Hit
	Mean Rank	10.8	14.5	0 False Neg
	Median Rank	10.0	13.5	23 False Pos
H	167	13	46	Hit
(15)	168	5	31	Hit
	169	1	24	Hit
	170	3	5	Hit
	Mean Rank	5.5	26.5	0 False Neg
	Median Rank	4.0	27.5	19 False Pos
I	171	4	10	0
(16)				1 False Neg
				27 False Pos

Table 2.3B Rank Order Retrieval Of Relevant Documents (Among 188 Documents) In C-Space And A-Space In Response To Requests A-K When Processed As Requests 1-18 (Continued)

Request	Relevant Document	C-Space Rank	A-Space Rank	Keyword Retrieval
J	114	5	4	0
(17)	115	14	1	Hit
	Mean Rank	9.5	2.5	1 False Neg
	Median Rank	9.5	2.5	7 False Pos
K	172	70	12	Hit
(18)	173	1	2	Hit
	174	10	5	0
	175	24	22	0
	Mean Rank	26.25	10.25	2 False Neg
	Median Rank	17.0	8.50	23 False Pos

All Requests		C-Space	A-Space
	Mean Rank	15.95	16.07
	Median Rank	11.77	11.50
All Relevant Documents			
	Mean Rank	17.05	17.45
	Median Rank	10.0	10.00

Table 2.3C Comparison Of Original And Reformulated Requests

Request	Mean Rank C-Space Original	Mean Rank C-Space Reformulated	Mean Rank A-Space Original	Mean Rank A-Space Reformulated
A	36.2	10.60	47.9	15.00
C	18.5	11.25	16.5	13.25
D	46.2	25.00	56.0	27.60
F	17.1	11.50	18.9	15.00
Mean	29.50	14.59	34.85	17.71

Table 2.3D Relevant Documents Retrieved In The Successive Phases Of The Retrieval Sequence

C-Space

Request	Number of Relevant Documents Retrieved At Stages								Total Relevant
	1-10	11-20	21-30	31-40	41-60	61-80	81-100	101-140	141-188	
A	6	2	0	1						9
B	1	0	2	0	0	1				4
C	3	0	0	1						4
D	2	1	1	0	0	1				5
E	2	1	0	0	3	1				7
F	9	3	3	1						16
G	3	3								6
H	3	1								4
I	1									1
J	1	1								2
K	2	0	1	0	0	1				4
All	33	12	7	3	3	4				62

Table 2.3D Relevant Documents Retried In The Successive Phases Of The Retrieval Sequence (Continued)

A-Space

Request	Number of Relevant Documents Retrieved At Stages 1-10	11-20	21-30	31-40	41-60	61-80	81-100	101-140	141-188	Total Relevant
A	5	3	0	0	1					9
B	4									4
C	3	0	0	1						4
D	2	1	1	0	0	0	1			5
E	0	2	1	1	1	2				7
F	9	4	1	0	1	1				16
G	3	1	2							6
H	1	0	1	1	1					4
I	1									1
J	2									2
K	2	1	1							4
All	32	12	7	3	4	3	1			62

3.0 Attribute Space Retrieval In An Operational Setting

As indicated previously, the Attribute Space procedure is one in which indexing and retrieval is accomplished on the basis of a conceptual content characterization of requests and of the documents (or other units) stored and retrieved. In contrast to the C-Space technology, the A-Space procedure has not previously been empirically vindicated in an experimental setting. Thus, one of the primary aims of the present study was to establish a gross level of success for Attribute Space indexing and retrieval in an operational setting and in response to relatively naturalistic requests for information. A second goal was to identify investigatable problems the solution to which would advance the state of the art in Attribute Space indexing and retrieval. A third major aim was to provide a basis for comparison with the Classification Space procedure in the same setting and suggest ways in which the two procedures might be most effectively combined.

The Attribute Space Retrieval Study (also referred to hereafter as the ASR Study) made use of the Attribute Space constructed previously (RADC-TR-65-314). For this study only a portion of the latter A-Space was used. That portion, summarized in Table 3.0A, is referred to below as simply "The

A-Space". Table 3.0A shows 31 common factors. In terms of the analysis presented in RADC-TR-65-314, the 31 factors in the present A-Space include twelve "Category" factors, thirteen "Functor" factors, and six "Property" factors. These are identified, respectively as factors C1-C12, F1-F13, and P1-P6 in Table 3.0A.

Table 3.0A Attribute Space

Space and Factor		Variable	Loading	Variable	Loading
C1	Electromagnetic	1	.972		
C2	Biological	2	.947		
C3	Conceptual	3	.882	37	.829
C4	Mathematical	4	.868	38	.665
C5	Observational	5	.824		
C6	Temporal-Sequential	6	.819	42	.756
C7	Experimental	7	.790	43	.785
C8	Linguistic	8	.785	44	.720
C9	Mechanical	9	.764		
C10	Conventional	10	.756	48	.625
C11	Chemical	11	.692		
C12	Geometric	12	.834	39	.777
F1	Identity	13	.913	40	.821
F2	Cost	14	.989		
F3	Velocity	15	.892	47	.866
F4	Factual Implication	16	.843	36	.837
F5	Weight	17	.873		
F6	Composition	18	.781		
F7	Boundary	19	.776		

Table 3.0A Attribute Space (Continued)

Space and Factor		Variable	Loading	Variable	Loading
F8	Validity	20	.782	32	.792
F9	End Focus	[illegible]	.750	35	.696
F10	Maintenance	22	.735	28	.724
F11	Quantity	23	.725		
F12	Structural Parts	24	.715	41	.649
F13	Duration	45	.741		
P1	Bad	25	.935		
P2	Demand Characteristics	26	.874	33	.832
P3	Small	27	.802		
P4	Process	29	.698	46	.642
P5	Good	30	.784	34	.638
P6	Part	31	.675		

3.1 System Vocabulary and Document Indexing

Each of the 1125 system vocabulary terms were rated against each of the 48 variables listed in Table 3.0A. Toward this end, the system vocabulary terms were segregated by reference to the subject matter field most closely associated with the document (among the 188 documents used in the CSR Study) in which the terms appeared or the subject matter field to which they were "distinctively" associated by the users (see Section 2.1). The number of terms associated with a given subject matter field ranged from 23 to 126. Judges were selected in terms of their competence in the subject matter fields. With few exceptions the A-Space judges were the same individuals as the C-Space judges. Each judge rated only those terms associated with his field of competence, but he rated these with respect to every one of the variables in Table 3.0A. The number of judges making A-Space ratings in each field is shown in Table 2.1A in the second parenthesis following the name of the field. (The first parenthesis gives the number of C-Space judges.) In contrast to the C-Space procedure, previous studies indicate a working minimum of five judges in order to obtain a stable average for A-Space judgments. Table 2.1A shows that this goal was reached for only seven of the twenty-three fields and that

in five fields the number of judges was less than three. Thus, as in the case of the C-Space, the fact that the experimental conditions were substantially less than optimal is a basis for considering the quantitative evaluation of the A-Space retrieval to be conservative rather than inflated.

Given the averaged ratings of each of the 1125 vocabulary terms against each of the variables in Table 3.0A, thirty-one A-Space coordinates were assigned to each vocabulary term by means of the same third-power weighted-average formula that was used in assigning C-Space coordinates. The assignment of these coordinates gave the 1125 terms the status of system vocabulary for A-Space indexing and retrieval.

The 188 documents used in the CSR study were also automatically indexed in the A-Space by means of the same Classification Formula that was used in the CSR Study.

3.2 The Attribute Space Retrieval Experiment

This experiment was in every respect parallel to the Classification Space Retrieval Experiment. For example, the same requests were processed, so that the same documents were relevant in both experiments. Likewise, the pool of 188 indexed documents was the same. In particular, the method of retrieval was the same; i.e., retrieval in the order of A-Space distance from the point-location of the automatically indexed request.

The results of the experiment were given in Table 2.3A and Table 2.3B, which show the retrieval rank of the documents judged by the user to be relevant to each request. Both mean and median rank are shown. Because the level of statistical significance of these results is, by inspection, considerably beyond the traditional .01 level, statistical tests of significance are not reported.

To facilitate comparison, other ASR Study results were presented earlier in conjunction with CSR Study results. Thus, Table 2.3D shows, for each request, how many relevant documents appeared among the first ten documents retrieved, how many appeared in the next ten, etc.

This table shows that, overall, more than half of the

62 relevant documents appeared in the first ten documents retrieved, and approximately three quarters appeared in the first twenty documents retrieved.

3.3 Comparison of CSR and ASR Results

The results of the two studies show a very similar degree of overall effectiveness for the two indexing and retrieval procedures. Thus, for example, Table 2.3B shows a mean retrieval rank of 15.95 for the CSR and 16.07 for the ASR when each request is treated as a unit. Likewise, it shows a mean retrieval rank of 17.05 for the CSR and 17.45 for the ASR when relevant documents are not classified by request. Again, the sequential retrieval of relevant documents summarized in Table 2.3D shows the sequence 33-12-7-3-3-4 for the CSR and the sequence 32-12-7-3-4-3-1 for the ASR. Thus, in terms of overall measures of indexing effectiveness, the two procedures are essentially indistinguishable.

However, an examination of the effectiveness of retrieval for individual requests shows that the A-Space indexing and C-Space indexing are far from being duplicate procedures. Table 2.3B shows that in three of the eleven requests (B,J,K) the A-Space retrieval was substantially more effective than the C-Space, and that in two other cases (H,I) the C-Space retrieval was substantially more effective than the A-Space.

The fact that conceptual content indexing is no less effective than subject matter indexing in the automatic processing of information requests may appear surprising, since information requests are commonly thought of as being pretty much the same thing as subject matter requests. And this result may appear all the more surprising, considering that the conceptual content indexing was based on a content domain derived from ordinary language, whereas the requests which were processed were of a highly technical character. However, it has been pointed out previously that there is no single, simple format for formulating information needs. The two studies previously reported were based on the expectation that subject matter and conceptual content would prove to be two major forms for expressing information needs, and the present results may be regarded as a significant confirmation of that expectation. Likewise, reasons were presented in RADC-TR-65-314 for supposing that the conceptual scope of technical locations does not substantially exceed the conceptual scope of ordinary, non-technical discourse. The present results are consistent with this reasoning.

3.4 Joint Use of C-Space and A-Space Indexing

The fact that the C-Space and A-Space retrieval procedures were on the whole equally effective and showed a substantial degree of complementarity in the effective processing of individual requests strongly suggests that the joint use of the two procedures will offer a significant improvement over the use of either one alone. This conclusion is also consistent with the discussion in Section 4.

In order to put this conclusion on an empirical basis, a simple procedure was adopted for joint indexing and retrieval in what may be called a CA-Space. Briefly, the procedure was to index each request separately in the C-Space and A-Space, compute a retrieval rank for each of the 188 documents in the C-Space and A-Space separately, and then multiply the two retrieval ranks for each document to obtain a CA rank-product. Documents were then ranked in the order of their CA rank-product, and this rank was designated as the CA-Space retrieval rank for each document. Retrieval of documents was carried out in the order of the CA-Space retrieval rank.

A summary of the CA-Space retrieval is shown in Table 3.4A and Table 3.4B, together with corresponding data for the CSR and ASR. Two of the eleven requests previously processed

were omitted from this analysis. Requests A and F were omitted because the composite processing of these requests (see Section 2.3) in the CSR Study and the ASR Study would have made it extremely difficult to perform the multiplication required by the CA procedure and to interpret the results. Request I was omitted from the analysis of the highest retrieval rank of a relevant document for each request (Table 3.4B) because there was only one relevant document for this request.

For the nine requests analyzed, Table 3.4A shows the mean CA retrieval rank (12.0) to be substantially lower than either the mean C-Space retrieval rank (17.3) or the mean A-Space retrieval rank (16.3). Considering the nine requests individually, the mean CA retrieval rank was lower than that for the C-Space in seven of the nine cases and lower than that for the A-Space in six of the nine cases; in five of the nine cases, the mean CA retrieval rank was lower than <u>either</u> the corresponding C-Space and A-Space ranks. Consistent with these figures, Table 3.4B shows that on the whole the lowest-ranked relevant documents have a lower rank in the CA retrieval than in either C-Space or A-Space retrieval. Likewise, the highest ranked relevant documents have a lower rank (i.e., are retrieved sooner) in the CA retrieval than in either the C-Space or A-Space retrieval.

The foregoing results present a consistent picture of CA-Space retrieval as an improvement over either C-Space retrieval or A-Space retrieval. The first relevant document is retrieved earlier; the last relevant document is retrieved earlier; and on the average, relevant documents are retrieved earlier.

Table 3.4C gives a picture of sequential retrieval under the CA procedure. As with the CSR and ASR, approximately half of the relevant documents are among the first ten documents retrieved, and more than three-fourths of the relevant documents are among the first twenty documents retrieved for a given request. Of particular importance is the relative absence of "gaps" in which no relevant documents are retrieved (represented by zeroes in Table 3.4C), both absolutely and in comparison to the CSR and ASR results (Table 2.3D). The data of Table 3.4C may be reformulated as follows: If CA retrieval were carried out in batches of twenty documents, then as soon as a user received a batch containing no relevant documents, he would know that there were no more relevant documents in the system.

Although admittedly grandiose if considered as a flat experimental generalization, the fact that such a formulation can be given as a summary of the present data suggests that the

ideal of complete retrieval within a manageable number of trials is not completely out of sight.

Some comparison with the baseline provided by the keyword indexing may also be informative. For the nine requests processed in the CA-Space, keyword retrieval produced 26 relevant documents (out of 37) among a total of 190 documents retrieved, giving an average of 7.3 trials per relevant document retrieved. Given document by document retrieval, the CA-Space procedure would require 226 trials (documents) to produce all 37 relevant documents, giving an average of 6.1 trials per relevant document. That is to say, the present CA procedure would give complete retrieval with greater per-document economy than a keyword procedure which may be generally expected merely to "skim the cream" of easily identifiable relevant documents leaving a residual (30 percent in the present case) which must be attacked by auxiliary methods which suffer increasing loss of efficiency as they approach completeness of retrieval.

In summary, the joint use of the C-Space and A-Space procedures appears definitely to be a significant improvement over the use of either one alone. The results now at hand represent a substantial achievement in the way of indexing and retrieval effectiveness and offer considerable scope for further development.

Table 3.4A Joint C-Space And A-Space Retrieval

Request	Mean C-Space Rank	Mean A-Space Rank	Mean CA-Space Rank
5	27.5	5.8	10.6
7	12.5	13.3	13.5
8	25.0	27.6	21.1
10	34.7	36.4	29.7
14	10.8	14.5	8.2
15	4.0	10.0	3.0
16	5.5	26.5	7.3
17	9.5	2.5	1.5
18	26.3	10.3	13.1
Mean	17.3	16.3	12.0

Table 3.4B Joint C-Space And A-Space Retrieval

Request	Lowest C-Space Rank	Lowest A-Space Rank	Lowest CA-Space Rank
5	10	2	1.5
7	2	4	2
8	5	2	3
10	2	11	9.5
14	6	1	1
15	1	5	1
16	4	10	3
17	5	1	1
18	1	2	1.5
Mean	4.0	4.2	2.6

Table 3.4B Joint C-Space and A-Space Retrieval
(Continued)

Request	Highest C-Space Rank	Highest A-Space Rank	Highest CA-Space Rank
5	64	10	16
7	37	32	34
8	70	90	48
10	72	70	65
14	13	30	14
15	13	46	17
17	14	4	2
18	70	22	27
Mean	44	38	28

Table 3.4C Sequential Retrieval In The CA-Space

Request	Retrieval Order 1-10	11-20	21-30	31-40	41-60	61-80	81-188	Total Relevant
5	1	3						4
7	2	1	0	1				4
8	2	1	0	1	1			5
10	2	1	1	1	1	1		7
14	3	3						6
15	3	1						4
16	1							1
17	2							2
18	2	1	1					4
All	18	11	2	3	2	1		37

4.0 Linguistic Data Processing

The field of linguistic data processing (LDP) is commonly considered to be roughly fifteen to twenty years old. Its short history has been characterized by cycles in which high hopes for a "breakthrough" resulting from new techniques have been followed by relatively modest success and subsequently, by the further search for more effective techniques. Recent years have seen a more guarded optimism and even some pessimistic overtones. For example, one national survey of the state of the art in 1964 resulted in the conclusion that indexing and retrieval had not progressed beyond the basic logic of McBee card sorting. Such a state of affairs suggests that current and recent approaches to linguistic data processing are subject to basic limitations which are as yet unrecognized, hence hardly likely to be surmounted.

4.1 The Case for an Alternative to Current LDP Approaches

The view taken here (see Appendix P and Appendix Q) is that current LDP approaches are in fact subject to basic limitations and that the relevant issues are methodological rather than merely technical. These limitations reflect the basic characteristics of semantic theory as formalized by Tarski, Carnap, and others.

The relevance of semantic theory stems from the fact that our currently accepted philosophy of science is, on the face of it, simply an extension of the methodology and logical forms of semantic theory to subject matters other than language. (Since it would be beyond the scope of the present report to document such a claim, let it suffice for the present to point out the obvious parallel between (a) the semantic distinction between object language and meta-language, and the relation between them and (b) the methodological distinction between "observation language" and "theoretical language" and the relation between them.) The limitation in question may be summarized by saying that linguistic data processing requires a pragmatic theory, not merely semantic theory.

One of the critical issues in this regard is the linguistic stratification required by semantic theory as a condition for the technical possibility of stating truth conditions for propositions and identifying the meanings and referents (extension, denotation) of descriptive expressions. One result of this stratification is that the meta-language remains unexamined. Since the meta-language must be at least as rich as the object language (i.e., it must be possible to say in the meta-language

anything that can be said in the object language) in order to perform its semantic task of characterizing the object language, what is left unexamined is, in an important sense, the whole of language. If one were in a position to say that the expressions in the meta-language had the same meanings as the corresponding expressions in the object language, the difficulty would be substantially reduced (for example, if one were able to say that both instances of "snow" had the same meaning in the sentence "The sentence 'snow is white' is true if and only if snow is white" or in the sentence "The referent of 'snow' is snow"). But that is what the logical structure of semantic theory makes impossible, since such a statement could be made only in a meta-meta-language where the identical problem would arise once again. This difficulty cannot be resolved by noting that one can always move to the next meta-linguistic level, for each such move carries the problem along with it. Thus, in regard to natural language, the stratification required by semantic theory leads directly to the following conclusion: Either we are involved in an infinite regress of meta-languages, in which case the situation is hopeless, or else we recognize that natural language cannot be adequately described.

The latter conclusion may appear to be equally hopeless, but in fact it is not. What follows is merely that our basic access to natural language is not in having a description of it, but in being able to use it. From this there follows directly a basic methodological principle for linguistic data processing: The only LDP system which could be adequate <u>in principle</u> is one which

reproduced the ability of persons to use natural language. Such a system is to be contrasted with one which is a technical implementation of some <u>description</u> of the language. (Any mapping of the language into some descriptive system or frame of reference, e.g. algebraic, set theoretical, or electronic, will qualify as a description of the language.)

A very different type of conclusion appears to have been drawn, however, by most scientific investigators. Semantic theory does, in a technical sense, permit the statement of truth conditions for propositions and of the meanings and referents of descriptive expressions. The existence of theories of this sort appears to have generated (or at least, protected from critical examination) the notion that we have knowledge about the world around us prior to, and independently of, language. On this view, language enters the picture after the fact, in connection with communicating the knowledge which we acquired independently. Since the thesis that we have a prelinguistic access to reality is commonly buttressed by reference to the apparently conclusive fact that there are individuals (e.g., pre-verbal infants and non-human animals) who respond to their surroundings and yet have no language, the thesis has achieved essentially universal acceptance. (This issue is dealt with directly in Appendix Q.)

In a specifically linguistic context the thesis that we have a prelinguistic access to reality appears in a specific form, i.e., the thesis that the phenomenon of communication via language is itself basically non-linguistic and non-communicatory. Since

in the general case the prelinguistic reality to which we are supposed to have access is taken for granted to be a physical reality (the issue is dealt with in Appendix Q) it is hardly surprising that in the special case of linguistic phenomena the reality of those phenomena should commonly be considered to be a physical reality.

Thus, the problem raised by the conclusion that natural language cannot be adequately described has been met by concluding that the phenomenon is basically a physical one, hence can be known without being described. But this is not a solution to the problem, for to say that the phenomenon is basically a physical one is merely to say that a physical description of the phenomenon is an adequate one. If a natural language cannot be adequately described within the scope of natural language it is surely paradoxical to suppose that it could be described within that small portion of natural language that deals with physical facts and concepts.

One important variation on the notion that a subportion of a natural language provides an adequate description of that language is the claim that for effective linguistic data processing we do not need an adequate description of the language, but rather, it is sufficient if we have some technical means for distinguishing everything that is distinguished in that language. Current approaches involving keywords, citation indices, associative indices based on keywords and co-occurrences, discriminant analyses, and grammatical descriptions of text may be seen in this light whether or not the conceptual derivation presented above is actually a part

of their history. (The derivation is not intended as a recapitulation of anyone's thinking; rather, it is a reconstruction of what it is that is commonly taken for granted and left <u>entirely</u> unexamined.) As conceptual systems, they share the feature of being grossly restricted in scope as compared to natural language. Among them, only the grammatical description appears, on the face of it, to provide any possibility at all of distinguishing what is distinguished within ordinary language.

We should have to ask, however, whether it really is sufficient, for the general implementation of automatic linguistic data processing, to have an implemented (computerized) descriptive system having merely the formal capability of distinguishing between any two English (for example) expressions (or between what the latter distinguish). And it appears that the answer will have to be "no," for if there is no way of telling <u>what</u> it is that is being distinguished, simply being able to distinguish it is of no value (in general). The relevant consideration is the difference between (a) making the same distinctions and (b) distinguishing the same things. Suppose, for example, we had a device which, by using the real numbers as descriptors, identified and distinguished the same things for which we currently use English expressions. Such a device would numerically distinguish among the different colors (for example) which we do distinguish. But if we did not know <u>what</u> color was distinguished by what number that device could not serve the function of language and would not be an effective indexing technique.

One way of trying to deal with this problem would begin by saying "The human user knows what distinctions are being made, and if he knows that, the system need not". This is a statement of the conditions under which we have in fact been able to use computers effectively in the ways that we have. But these ways do not include effective automatic linguistic data processing. Here we should note that the user would have to know not merely both sets of distinctions (his own and the system's) but also the connection between the two, and if the connection were a merely factual one he would have no way of knowing what it was. Suppose, for example, that the user merely wanted to know how many kinds of solar power sources there were. Given (to take the simplest case) keyword indexing, the system would distinguish between documents (or other textual units) in which "solar power source" occurred and those in which it didn't. And suppose that the user knew that this was the relevant distinction being made by the system. He would still not know what the relationship was between documents which mentioned solar power sources and documents in which the expression "solar power source" occurred. Many false negatives and an appreciable number of false positives would be expected here. Equally important, the user would have no way of estimating what he was missing that was in the system and no way of estimating what the system might be missing. Adding other keywords, adding words which co-occur with keywords, selecting documents cited by documents in which keywords or their associates appear, or any other similar device would in general open up the possibility of

more effective retrieval (though that result would in no sense be guaranteed), but in principle all such elaborations would be subject to the same limitation and the gain in effectiveness resulting from such elaborations might well fall substantially short of meeting the information retrieval requirements of a given mission. Historically, this has frequently been the case.

These considerations lead to the conclusion that even a fully computer-implemented grammar plus lexicon would not be sufficient for the general task of linguistic data processing. Indeed, it is clear that the information contained in a sentence is not a determinate function of that sentence alone but rather, is a joint function of that sentence and others that come before and after. The conceptual interrelationships among facts and among statements is indispensible to the identification of the information given by a particular statement.

The difficulty that has been identified in connection with current LDP approaches may be formulated succinctly in information theory terms. The thesis that linguistic events and processes are "really" physical events and processes may be reformulated as the thesis that signals are merely physical events and that the information content of a signal (or at least, its information potential) can be discovered by establishing the physical parameters of that physical event or process.

The keystone of information theory thinking is that what makes a physical event a signal is not the physical properties of the event, but rather the existence of a receiver, and that the

information content of the signal is a reflection of the specific functional characteristics of the receiver. Thus, even if the thesis that the information content of a signal, S, relative to a receiver, R, could be ascertained by establishing the physical properties of the physical event, s, corresponding to S, were correct, it would nevertheless be subject to a particular qualification, i.e., that one could not know that he had established the relevant physical properties except by having a receiver, R^1, which had the same functional characteristics as R. For example, examining a crystal under a lens or with calipers would not tell us that it was broadcasting a tune by virtue of its electromagnetic properties. Nor would an electromagnetic receiver tell us that it was broadcasting a tune unless that receiver was designed to respond to tunes. To take another example, neither would the measurement of length, direction, and coincidences of three lines tell us that here was the letter "F". Evidently the physical description of the signal is simply a methodological analogue of the numerical descriptor produced by the hypothetical device in the example above. Thus, with respect to linguistic data processing, the qualification is decisive, for it leads to the same conclusion that was arrived at previously, that is, that the only linguistic data processing system which is adequate in principle is one in which the same distinctions are made as are made in ordinary language. (Ordinary language is here taken to include technical terminology as a part.)

4.2 The Characterization of a Constructive Alternative

It is not clear to what extent the conclusions drawn above are novel. Probably few investigators would take issue with the statement that in principle an adequate LDP system must make the same distinctions as are made in the language to be processed. On the other hand there is little evidence that the leading workers in the field use this criterion as anything other than the final criterion for evaluating the success of a given LDP system. What is suggested by the foregoing, however, is the possibility, if not necessity of setting up a system in which making the same distinctions as the language to be processed is the basic operating principle and not merely an external criterion of success.

It seems likely that the failure to use the "same distinctions" concept as an operating principle is the result of there being available no systematic conceptualization of the use of language, i.e., no adequate "theory of performance" in regard to verbal behavior. Recently such a formulation has become available. (see Ossorio, 1966) For convenience of reference, a recent report relating this conceptualization to learning theory in Psychology and to generative grammars in Structural Linguistics is included here (Appendix P) with the permission of the publisher. Because of its connections to the British linguistic-analytic philosophy developed by Wittgenstein, Ryle, Austen and a generation of their students, the general conceptualization of the use of language which underlies the research program delineated below in Section

4.3 is summarily designated as "The Rule-following Model" of human behavior. The alternative designation is "The concept of a Person".

Appendices P and Q are intended to carry the primary weight of the presentation of the Rule-following Model. The following is a selection of aspects most directly relevant to linguistic data processing.

(1) The domain of behavior is considered to be primary and to include within it all other domains such as those of physical objects and of mathematics. Although for most practical purposes one may speak of distinct domains and descriptive (conceptual) systems here, the feature of inclusion ensures that we are able to make use of whatever is known in any domain in our dealing with behavior.

(2) The statement of the primacy of behavior is given as follows:

First, the concept of intentional action is introduced as both the basic unit of behavior (in terms of content) and the "universal law" of behavior (in terms of use). Intentional action is an observable behavioral process which is defined by specifying four parameters ("want", "know", "know how", and "performance") as being relevant. (Analogously, we might define a physical object as one to which the parameters of position, motion, and mass were relevant.) One of the parameters of

intentional action is that of "knowledge", which is to say, the use of concepts. (To use the concept of an X is to distinguish an X or a class of X's from some correlative set of non-X's.)

Second, because the use of a concept is ipso facto a case of intentional action, the use of the concept of intentional action provides an instance of that very concept. (In contrast, for example, the use of the concept of a physical object or of a mathematical function or of a conditioned response is not itself a case of a physical object or of a mathematical function or of a conditioned response because the defining parameters of none of these latter are the same as the defining parameters of the phenomenon [intentional action] which qualifies as a case of using those concepts.)

Third, the concept of intentional action is shown to be a logical component of a more complex concept, i.e. the concept of a Person. Formally, the concept of a Person is an interrelated set of classes of logically primitive functions, designated as "person functions", which take intentional actions as their arguments and have intentional actions as their values. The domain of application of these functions defines the domain of behavior. Informally, the relation of intentional action to Person is given by the following two statements:

(a) An intentional action is what a Person <u>does</u>.

(b) A Person is an individual (in the neutral logical sense) whose history is a history of intentional actions which are expressible as person functions of intentional actions simpliciter. Likewise informally, the division between intentional actions and Persons, and the relation between, them is methodologically analogous to the familiar division between universal laws and initial conditions, and the relationship between these.

Fourth, the use of the concept of a Person is the defining characteristic of a Person. (Compare "the use of the concept of mathematics is the defining characteristic of a mathematician" or "the use of the concept of chess is the defining characteristic of a chessplayer".) Specifically, if an individual has the competence ("ability" refers to one of the classes of "person functions") to use the concept of a Person, then necessarily, he is a Person.

(3) The foregoing is sufficient to establish the following two points with respect to the Rule-following Model. First, it has the reflexive logical structure of natural language (saying something is simply a special case of intentional action) and thereby avoids the methodological difficulties and limitations resulting from the stratification inherent in semantic models. Second, it is an information-theoretical formulation in the methodological sense indicated in Section 4.1, though it is not so in

the technical sense of being an instance or variation of quantitative information theory. That is because it provides a conceptualization of what the information in question is rather than merely how much of it there is.

(4) A different way of expressing both the autonomy and completeness of the domain of behavior is the following: "The primary function of the concept of a person is to guide the behavior of one person vis a vis other persons". ("The concept of X guides P's behavior" is an equivalent way of saying "P uses the concept of X".) Methodologically, the statement is analogous to the following: "The primary function of the concept of chess is to guide the behavior of one chess player vis a vis another." This is sufficient to characterize the Rule-following Model as a "systems" formulation, i.e. it is a way of conceptualizing the domain of behavior as a system of interrelated behavioral processes (the several logical features which are constitutive of "process" are collectively designated as the "performance" parameter of intentional action). This feature of the model is one of the primary conceptual bases for the construction of a linguistic data processing <u>system</u> designed to reproduce essential features of the behavioral processes (social practices) which are constitutive of the information content of linguistic expressions.

(5) The foregoing may be used to exhibit the inclusiveness of the domain of behavior in the following way: Although the primary function of the concept of chess is to guide the behavior of one chess player vis a vis another, it may be used in other ways as well, for example, in buying a chess set or in describing a game to someone. Both the primary function and these latter, secondary functions are equally subsumable under the more general concept of intentional action, in that all of these involve some person(s) <u>doing</u> something. Similar considerations will hold for the conceptual-descriptive systems proper to particular disciplines (e.g., mathematics, linguistics, aesthetics, athletics) and to particular sciences (e.g., physics, chemistry, biology, neurology). The limits of the possible use of a concept, X, are the limits of the possible intentional actions and social practices which turn on the distinction between that sort of thing and other things (X vs non-X's). Saying something (the phenomenon of language) is a form of behavior the primary function of which is to make those distinctions and to mark them. Thus, the limits of the possible uses of language are the same as the limits of the possible uses of concepts. Conversely, any system in which the distinctions corresponding to the uses of concepts are preserved will be a system within which the use of language can be represented and,

potentially, reproduced. This is why a rigorously general conceptualization of behavior is presented as the only conceptualization which provides a methodologically adequate basis for a technical implementation in the form of a linguistic data processing system.

(6) Part of the force of saying that in the Rule-following Model the domain of behavior is primary and all-inclusive is the elimination of the apparent distinctions between substantive and functional definitions. In the Rule-following Model all distinctions are functional distinctions. This is in fundamental contrast to the traditional semantic model in which the primary phenomenon is the naming and description of objects. In the present formulation, "object", "process", "event", and "state of affairs" represent the generic forms of conceptualization of "reality." That these are formal (functional, or systematic) concepts rather than labels for prelinguistically known objects, etc. is shown by the fact that "object", "process", "event", and "state of affairs" are defined by their relationship to one another and are substantively neutral with respect to what kind of objects, processes etc. are involved (see Appendix Q for more extended presentation). This is to say that the reality of particular objects, processes etc. or classes of objects, processes, etc. lies in (a) there being forms of behavior which require the dis-

tinction of this object or type of object (or process, etc.) from others and (b) whatever limitations there may be on individuals' abilities to avoid particular forms of behavior which are within their capabilities and which require this distinction.

(7) Because of the generic importance of the concepts of "object", "process", "event", and "state of affairs", which are designed collectively as "observation concepts" (see Appendix Q) it would appear that the technical implementation of this conceptual system would provide one of the most direct and viable ways of implementing the Rule-following Model. It is this suggestion which may be directly translated into the linguistic data processing system outlined below. For reasons which will be obvious upon presentation of the design, that system is here designated as a "State of Affairs Model," abbreviated as "SAM."

(8) The formulation of "object", "process", "event", and "state of affairs" as systematic, formal concepts also provides the basis for the resolution of the problem of reconciling methodological, or "in principle" adequacy with the technical limitations associated with the present state of the art. That is, a system will be methodologically adequate if it provides the resources required for distinguishing among the four basic observational concepts for implementing calculus of

transitions among them (see Appendix Q). The system will be substantively adequate with respect to a given field of knowledge or endeavor to the extent that it is able to represent the use that is made of the concepts pertaining to that field. The system will be substantively adequate with respect to a given concept to the extent that it is able to represent the totality of behaviors in which that concept may be used. The program described below for constructing a state of affairs model reflects a particular decision as to the most effective strategy in advancing the present state of the art. Primary emphasis is given to the task of achieving methodological adequacy both in the interest of future generalizability and because it is the thus far most neglected aspect of linguistic data processing. Thus, a major part of the presentation below deals with the construction of a number of distinct subsystems each of which corresponds to a generic type of concept (e.g. a "subject matter" subsystem and a "conceptual content" subsystem of the types described in previous reports as a "Classification Space" and an "Attribute Space") which is to be implemented by that subsystem. Equally important (see below) is the set of interrelationships among the subsystems.

However, methodological adequacy does not exist in the abstract -- it can be demonstrated only by

demonstrating some degree of substantive adequacy. The recommendation contained in the program described below represents a compromise solution to the general problem of substantive adequacy. That recommendation is to demonstrate substantive adequacy with respect to some domain of knowledge or endeavor rather than with respect to particular concepts per se, and further, to minimize state of the art problems in this connection by selecting a domain of knowledge or endeavor which is sufficiently simple, isolable, and well-known to offer the prospect of no in-principle problems but also sufficiently complex to provide a convincing basis for any test and demonstration of the adequacy of the relatively complex methodological formulation.

(9) In the light of the critique presented in Section 4.1 it will be of some value to state the following correspondences directly even though a rigorous statement would require considerable elaboration and some qualification: (a) The subsystems of the SAM perform directly the function of merely distinguishing the same things as are distinguished in the natural language, and as such they have the same limitations as those attributed to existing LDP procedures in Section 4.1. (b) It is the interrelationships among subsystems which permits one to say that the same distinctions are being made as are made in the natural language.

The difference is readily shown by reference to the existing Classification Space and Attribute Space systems considered now as SAM subsystems. The Classification Space is merely a device for distinguishing among different subject matters (like our hypothetical device in Section 4.1, it does so by using real numbers, i.e. coordinates, as descriptors) and reconciling the facts about the similarity relationships among subject matters. That is, the dimensions of the Classification space could equally well be spoken of as representing the ways in which subject matters differ from one another or as representing the ways in which they resemble one another. What one cannot do with the coordinate system per se is to distinguish <u>what</u> subject matter a particular subject matter is. (We have taken a step in that direction, however, as soon as we are able to use the A-Space to characterize the conceptual content of those terms which are particularly relevant to a given subject matter.) What makes the Classification Space workable as an information storage and retrieval system is that there are auxiliary methods for input and output. For example numerical descriptors can be assigned automatically by the system because in the first instance (i.e., the system vocabulary) assignments of this sort were made by a person who had that competence--the assignments made by the system are a

describable but not readily anticipatable function of the assignments made by persons. In retrieval, on the other hand, the problem is solved by, in effect, making use of an indirect description. That is, the retrieval criterion is not the selection of materials having such and such subject matter content but rather the selection of materials having _the same subject matter content as_ a given one, i.e., as the retrieval request which has already been given a subject matter assignment. Only a user who knew _which_ subject matter distinctions were functionally represented by which Classification Space reference axes _might_ be in a position to formulate a request directly in terms of the subject matter coordinates of the desired text, but in general, requests of the latter sort could not be expected to duplicate the results of requests of the former sort.

(10) Since "the interrelationships among the SAM subsystems" is the same thing as "the overall functional pattern of the system "and since the latter is what corresponds in principle to the use of the natural language, it will follow from the considerations presented in Section 4.1 that an adequate description of the overall functional pattern of the system cannot be given. As indicated in 4.1, however, this conclusion is neither paradoxical nor pernicious, since it is intelligible within the Rule-following Model and has merely the further conse-

quence that (a) our most fundamental access to natural language is not our having a description of it, but rather, our being able to use it; and (b) the only LCP system which could be adequate in principle is one which reproduced the ability of persons to use natural language.

To be sure, we can give _a_ description of the overall functional pattern of the system. For example we could (and will eventually have to) give such a description by reference to an executive program under which the system operated to coordinate the various subsystems. What we cannot do is to say _what it was about that program_, which, given the available subsystems and their characteristics, made it an adequate representation of the use of language and therefore suitable for reproduction the ability of persons to use the language. Still less could we non-trivially say in general what _a_ program would _have to be_ like in order to have that result.

However, although we cannot give a simple description of the required functional pattern, neither are we reduced to silence on the matter. Rather, the implication is that such partial descriptions as can be given will be illustrative rather than demonstrative. It will also be the case that such descriptions as can be given will also in principle, be capable of being represented within the resources of the system itself (for example,

by distinguishing a new subject matter, i.e., the description of systems such as this one, to which then the remaining subsystem resources, e.g., conceptual content means-ends, and process distinctions could be applied). Indeed, one of the subsystems described below is designed to serve as the primary nucleus for just this function of self-characterization. In turn, self-characterization along the formal lines of "object", "process", "event", and "state of affairs" provides a major avenue for "bootstrapping" which generates the capability for making more complex distinctions, hence also for more sophisticated uses of the concepts already implemented by the system. This is one reason why substantive adequacy with respect to concepts is not a criterion for the design of the system presented below as well as being one reason why it is impossible to give a literal functional description of the system--in addition to being recursive and reflexive in its logical design, it is an adaptive, information-generating system.

In summary, the situation is as follows: We may begin with a conceptually rigorous and methodologically adequate formulation of language and behavior (the Rule-following Model). We may use this formulation to derive principles which must be exhibited by a LDP system if it is to be an adequate one (making the same distinctions, i.e., "object", "process", "event", and

"state of affairs"). We may further identify a set of operating principles (the subsystems) which collectively satisfy the basic prescription (it is not clear that these are the only ones that will). And we may demonstrate that a given system has these operating principles (to within a satisfactory approximation of each). What we cannot do is to use the description of the system to demonstrate that it has these operating principles <u>in the right way</u>, for the only criterion of its having them in the right way is that it succeeds. Thus, although we cannot prove that it has those operating principles in the right way, we may hope to <u>show</u> that it does. But even if we do show this with respect to a given system, our potential for extending this kind of success will continue to depend primarily on our ability to use the concept of language as well as the language itself and only indirectly on the perspicuity of our descriptive achievements

4.3 The Presentation of an Alternative Approach to LDP

The primary characteristic of the program of research described below is that it makes use of the logic of behavior description as a standard and a guide to the automatic processing of linguistic data. In particular, the system of "observation concepts" presented in Appendix Q gives the basic formal structure for an operating LDP system. Because of the primary place of "state of affairs" among the observation concepts, the LDP system is characterized as a "State of Affairs Model" (SAM). The model has the following general features.

A. Since the concept of a state of affairs is the concept of a domain of facts, the State of Affairs Model is a model of a domain of facts.

B. Because a factual domain is a historical entity and can be expected to show temporal change, the model is an open-ended information-processing system capable of representing such changes.

C. Information dealing with changes within the domain has the pragmatic status of an observation report. (State of the art limitations require linguistic input rather than anything corresponding to sensory data.) Because of the systematic relationships within a domain of facts, an observation report will in general not merely <u>present</u> certain putative facts explicitly, but it will also <u>imply</u> or <u>suggest</u> others.

D. Given the distinction between implicit and explicit information, the former may in turn be divided into two kinds. The

first is a relatively simple function of what other current facts obtain in the current context -- for example, if X has been reported three times previously, then a report of X is not merely a report of X, but rather, it is the <u>fourth</u> report of X, and that suggests that there may be many cases of X. The second is a function of the conceptualizable transformations of the "direct" information which are possible by virtue of the concepts implementable within the system. For example, if an artifact, X, is reported at a certain location, one such transformation is provided by the concept of "ownership" (a particular "class membership" concept), and the artifact may be redescribed as one of the possessions of some individual, Y. The addition of this element to the preexisting set of Y's possessions may then permit a redescription of that set, either directly (e.g., he now has a complete something, a Z, where before he did not have a Z, thus using a part-whole transformation) or indirectly (e.g., he now has the means to do Q, where before he did not, thus using a means-ends or a process transformation) or both (e.g., having a Z may be what now gives him the means to do Q).

E. Although the software for the system is designed to represent a sequence of states of affairs, the operation of the system is not designed to simulate that sequence as a (possible) historical process. In this regard the present system differs fundamentally from existing simulation models. The difference may be put in the following form: Existing simulation models may be grossly represented by a set of operations performed upon

a set of elements in such a way as to generate sequences of the form "state_1 - operation - state_2 - operation - ... - state_n". The crucial feature of such models is that the operations in the model are analogues of the causal processes which bring about those changes in the real domain which correspond to the changes from one state to another in the model. Whatever other features the simulation may have, it is this feature which qualifies the entire operation of the model as a simulation of the phenomenon in question.

In contrast, in the SAM the system operations performed as a result of a system state which records information about a change of state in the domain in question are not analogues of causal processes which bring about subsequent changes in the domain in question. Rather, they are redescriptions of that same change of state, and the set of redescriptions is designed to (in principle) exhaust the information content of the input. The model is thus an instrument for cumulatively analyzing and collating the <u>information content</u> of various messages (documents, inputs, etc.) into a single, coherent system (the domain of facts) so that the totality of information is systematically and selectively available for retrieval without regard to the historical accidents of which items of information were received together in the same input message and without regard to verbal constraints on how much information is explicitly stated within single messages.

On the other hand, there is a relationship between the

present system and the traditional causal-process simulations. That is, the latter type of system is a limiting case of a state of affairs model. The limiting case is reached when the information available as input is equal to the maximum possible information for that system. When sufficient information is available to eliminate all possible uncertainty, the state of affairs model becomes a determinate system.

In line with the preceding discussion, it should be noted that the extent and type of possibilities that would have to be eliminated in order to achieve a determinate system are a consequence of the functional richness (logical complexity and representational capacity) of the system. In the present case the functional possibilities of the system are rich enough so that it would be highly unlikely that uncertainty could be eliminated simply on the basis of input. This is also a general feature of real life observations, particularly observations involving the activities of people. That is, we do not ascertain that a certain state of affairs exists by eliminating all possibility of being wrong, nor would it be logically possible to do so. Rather, we operate in a way which could be variously characterized: (a) We can be said to interpolate and extrapolate from directly given (e.g., observational) information, using our concepts of particular objects, processes, events, and states of affairs. (b) We can be said to enter a given situation with particular hypotheses (or expectations) which we test against our observations and accept, reject, or hold

in abeyance at any given time. (c) We make use of our concepts of particular objects, processes, etc, to judge (compute) which of these seems to be the case on the basis of observation (what descriptions of the factual input are valid). We make use of a flexible system of priorities for the use of one description over another, together with the maxim (operating principle) that if something seems to be the case we take it that it is the case unless we have some information to the contrary.

The last of these three characterizations most directly describes the State of Affairs model presented below. It is designed to operate on the basis of incomplete information because it appears that no system which required complete information could be adequate, in principle, for the task of linguistic data processing. It is the operating principles of the system which compensate for the missing information so that a determinate process of computer operation can take place, and clearly a good many possibilities are open here. This is why, although one could make a convincing case for the inclusion of particular subsystems, there is no way of demonstrating in advance that they are included in the right way or that no other subsystems are required.

In the paragraphs below, the subsystems for a functional State of Affairs Model are described separately. In subsequent paragraphs an effort is made to illustrate the operating characteristics of the system as a whole. There is naturally an appreciable redundancy between the two accounts.

4.3.1 A Description of Subsystems

The State of Affairs model is designed as an assembly of the following subsystems:

(1) Fact-Event Recording System (FERS)

(2) Classification Space (C-Space)

(3) Attribute Space (A-Space)

(4) Means-Ends System (MES)

(5) Part-Whole System (PWS)

(6) Inferential System

(7) Inductive System

(8) Operative Time System (OTS)

(9) Process-Activity System (PAS)

(10) Heuristic Programming System (HPS)

These subsystems, together with explanations of several relevant terms, are presented below.

(1) Attribute Space (A-Space)

This is a geometric model for attributes. In the present system, the attributes are those of the FERS. (See: Geometric Model; FERS)

(2) Classification Space (C-Space)

This is a geometric model for subject matter. In the present system, the subject matter domain is the same as the factual domain of the FERS. (See: Geometric Model; FERS)

(3) Ends Space (E-Space)

This is a geometric model for goals, or ends. In the present system, these goals are a subclass of the states of affairs

represented in the FERS, i.e., that subclass which is selected as comprising possible goals for some of the objects (persons) of interest which are also represented in the RERS. (See: Geometric Model; FERS)

(4) Fact-event contingencies

These are relationships which hold between one fact, event, or set of facts or events, on the one hand, and another fact, event, or set of facts or events, on the other hand. The contingency may be logical or empirical, but in either case information of certain kinds involving the first facts or events gives information of certain kinds about the second facts or events.

(5) Fact-Event Recording System (FERS)

This is a system which most directly represents a domain of facts and potential or possible facts. In principle, we may think of this representation as being accomplished by means of a binary characteristic which may be interpreted as "True-False" or "Factual-Nonfactual". In the simplest case, a fact has the general form "element A has (has not) attribute X". In more complex cases, facts will exist in the system in other logical forms such as "The value of functor F of element A is equal to N_1" or "The elements A, B, and C have the relation R(A,B,C)" or "If F(A) then G(B)".

The State, or Status, of an element, B, at a given time is the set of facts involving B at that time. An event is a change of state. The simplest event would consist of a

single element changing state with respect to a single attribute. Thus an event is characterized by a date only (time of occurrence), whereas a fact is characterized by a dated interval of time (it was a fact from date t_1 to date t_2, and its coming to be a fact and its ceasing to be a fact would be events). Both facts and events are to be distinguished from processes. (See: OTS; Appendix Q)

(6) Geometric Model

The geometric models referred to here are n-dimensional Euclidean models for two-place relationships, where similarity between first-place terms is represented by the angular separation between unit vectors originating at the origin, and similarity between second-place terms is represented by the distance between points in the space.

For example: One such two-place relationship is that of characterizing--"Element A is characterized by the attribute X". The geometric model for attributes is empirically derived from a set of attributes which are of interest (in the present case they are the PERS attributes. Each attribute is represented as a unit vector, and the similarity between any two attributes is represented as the angle between their vectors. Any element can be given a point-location (the model has a Cartesian coordinate system) based on the attribute-profile of that element. As a result, the similarity between any two elements is reflected in the distance between their respective locations. Naturally, there exists a converse

model in which the elements are represented as vectors and the attributes as points. This symmetry is illustrated in the use of both a Means Space and an Ends Space based on the single relationship "A is a means to X".

(7) Heuristic Programming System (HPS)

This system serves as a link between the relatively unrestricted use of linguistic resources (by Users or in input units) and the linguistic data processing capabilities of the system. The HPS "translates" data input or information requests (either analytically or via feedback interaction with a User) into a canonical form which can be processed efficiently by the remainder of the overall system. The alternative to having an HPS is to impose restrictions on the verbal form of input (either information or retrieval requests). More accurately, the state of the art in HPS will determine how much and what kind of restrictions on input format will be required.

(8) Inferential System

This system combines a deductive logic and hypothesis-testing algorithm with the fact-event contingencies relevant to the elements of the FERS. It is used to "infer" certain facts-events, given that certain other facts-events are directly inputted to the FERS buffer (the latter reports or observations would be in the nature of premisses), or given that they have been previously inferred. Although the contingencies are part of the FERS, the fact is that no "conclusion"

simply follows automatically from a given input. Rather, provisional conclusions are drawn and tested against existing information. Because the operations involved are likely to be extensive, the inferential system is here specified as a separate subsystem. Conversely, although the contingencies which serve as premises are used by the Inferential system, they are in principle modifiable by the Inductive System. Thus, although at a given time such contingencies may operate with deductive force, it is a matter of fact that such are the contingencies at a given time, hence this state of affairs is legitimately part of what is represented in the FERS.

(9) Inductive System

This system comprises a group of more or less closely interrelated functions: (a) It develops statements of fact-event contingencies and procedural rules for the Inferential System on the basis of frequency counts and whatever analytic methods are available within the system. Among the latter are means-ends and process concepts. That is, the inductive system may modify the operation of the Inferential System by reformulating some of those (inferential) operations on the model of activities (processes, means-ends hierarchies) which it already has available (by virtue of its access to these other subsystems) for representing the FERS domain of facts. (b) It monitors the accuracy of conclusions generated by the inferential system and overrides or eliminates statements of fact-event contingencies in the Inferential system when these

statements consistently lead to conclusions which conflict with observations (input) or with other conclusions having a higher priority. Or, corrections of this general sort may also be accomplished by altering the structure of data in the geometrical models. (c) It assigns validity statuses (e.g., in the form of probability or credibility weights) to the fact-events of the FERS.

(10) Means Space (M-Space)

This is a geometric model for means which are judged to be significant with respect to the "goals" of the E-Space and FERS.

(11) Means-Ends System (MES)

The Means-Ends system involves three components. The first two are the geometric models for means and for ends. The third is a system of means-ends hierarchies which preserve the branching tree structure of explicit means-ends formulations. (See: Means-Ends Study described in Section 5)

(12) Part-Whole System (PWS)

As presently conceived, this system has an analytic option and a geometric option. The latter consists of geometric models for part-part relationships (See: Part-Whole Study described in Section 5) and for simple part-whole relationships. The former is a set-theoretical calculus for representing, hence for deriving, part-whole relationships and class membership relationships. The reason for the

options in both the MES and PWS is to take advantage of the complementary character of the geometric models and the analytic models. The geometric models may be characterized as analogical, field-like, and relatively language-free, whereas the analytic alternatives may be characterized as digital, single-track, and relatively language-bound. The analytic and geometric subsystems might have considerable overlap, but would not, in general have the same set of items (means and ends, parts and wholes, elements and classes).

(13) Operative Time System (OTS)

The primitive function of this system is to record and maintain a time characterization for the SAM and especially, the FERS. It coordinates time points (dates) to events and dated intervals to facts. Thus, for example, information which is retrieved may also be characterized in terms of how up-to-date it is. More advanced functions would include (a) recovery of past states of the SAM or portions thereof (e.g., within the FERS); (b) projection to future states; (c) contribution to the representation of processes in the PAS, since change over time is a characteristic of processes (See: Appendix Q); and (d) identification of trends (in conjunction with, and to be used by, the Inductive System).

(14) Process-Activity System

The PAS is an analytic system containing distinguishable process or activity characterizations (See: Process-Activity Study described in Section 5). The primary function of process-activity descriptions is to assimilate "observed"

events to the stages of this or that process or activity in order to (a) interpolate missing observations and (b) extrapolate to future anticipatable events. Other functions include (c) providing a basis for change of inferential rules in the Inferential System and (d) the normal subsystem function of contributing descriptive power to other subsystems.

4.3.2 Outline of the State of Affairs Model as a Functioning System

The SAM is a model of some particular domain of facts (some particular sphere of interest), for example, a hospital, a city, a battle, a committee meeting, or the inside of a combustion chamber. Although the logic of the system is not restricted to any particular domain, a good many of the procedures must be specified in detail in terms of a particular domain.

A. The FERS operates as a simple information register (tells which elements have which attributes). When set into operation initially, all the latest known facts within the domain are entered into the FERS by a special program.

B. Input of information (about the domain) is to the FERS via the Heuristic Programming System and the FERS buffer. The HPS takes information in the form in which it is normally recorded and transforms it to a standard form (e.g., "Element A has attribute X") for input to the FERS buffer.

C. From the FERS buffer, before the direct input is registered in the FERS, it is processed by the Inferential System (a) for consistency with the structural rules (if any) of the domain, (b) for consistency with existing facts in the FERS, and (c) for any implications it may have in regard to other facts.

D. At the time when an entry is made in the FERS it is assigned a validity index by one of the Inductive System programs. Validity indexing is geared to the content and particularly, the transformations associated with the SAM domain. In general, a validity index (or indices) would take account of (a) source of information, (b) direct information vs inferential conclusion, and (c) consistency with existing facts in the light of their validity indices. Validity indices may be carried along in retrieval procedures for the benefit of the User. They are also used in resolving conflicts among inputs or among inferred conclusions. In a more advanced system the programmed assignment of validity indices would be treated as just another set of inferential rules (hence modifiable) by the Inductive system.

E. From the FERS buffer the implications (if any) of the direct input are drawn by the Inferential System. This process may require reference to (access to) any of the geometric models or the analytic models. For example, if the Inferential System contains an inference rule having a part-whole aspect of element Q as a premise, then any direct input involving Q would cause the Inferential System to refer to the FERS attribute of Q involved in the input and subsequently refer to the PWS in order to determine whether that particular attribute of Q had a part-whole significance (e.g., suppose that unless Q had the attribute P, it could not be a part of R).

F. If the Inferential System draws a conclusion from the direct input, the conclusion, which is in the form of a statement of fact,

is registered in the FERS buffer. If the fact in question is not already registered in the FERS, it receives the same processing as a direct input. Thus, the inferential process is a "last in - first out" arrangement, and no conclusion or direct input goes from the FERS buffer to the FERS proper until all conclusions involving that input have been drawn.

G. As input is registered in the FERS, it is time-dated by the OTS. In an advanced system, both the time of the recorded event and the time of the reception of the information at the SAM would be recorded.

H. Not necessarily at any given time (since, after all, input is dated), but during a constant monitoring process, the Inductive System constructs a success-failure table for each rule in the Inferential System. That is, it counts the number of times a given rule was used and the number of times a conclusion which was reached was (a) rejected as being incompatible with other facts, (b) changed as a result of direct input implying a contradictory statement, or (c) changed as a result of conclusions drawn from other inputs. Empirical or apriori critical values for the success ratio are used to delete unsuccessful inference rules.

I. During a constant monitoring process the direct input regarding Q (or the current state of Q) may be "counted" by an inductive system program which generates fact-event contingencies as hypotheses (e.g., by direct programming or by reference to "what resembles what" or "what is replaceable by what" in the geometric models) and predicts future events (via the OTS and PAS which

provide the format, the FERS or other "content" models, which provide the content, and the Inferential System, which draws the predictive conclusion). The Inductive System determines the success ratio of these hypotheses and transfers the successes to the Inferential System and the FERS.

J. Routine retrieval is accomplished via the HPS as an intermediary. The User may formulate his request either in formatted form (e.g., by subject matter, by conceptual content, by means-end relationship) or in natural, discursive form, if the HPS is capable of dealing with it. In either case, the request emerges from the HPS as a set of formatted retrieval terms which can be processed by the SAM. The formatting determines which of the "content" models, including the FERS, correspond to the primary form (as against indirect description--see below) of the request. The geometric models especially (but all the "content" models also) eliminate the necessity for literally naming the particular element(s) or attribute(s) involved in the facts desired as output. For example, the elements might be identified as all those elements for which a given attribute is meaningful (possible), or as those elements which resemble a specified paradigm element in particular attributes or generally. Likewise, the attributes to be used for output may be identified as those which resemble a specified paradigm attribute (i.e., are close to the named paradigm in the A-Space). Or, the request might be for all the facts or elements which were highly related to a given goal, or for the facts about (or merely the names of) all the elements (FERS) having characteristics

similar to (A-Space) the characteristics of any element (FERS) which ordinarily served as a means to a specified paradigm goal (MES) or had the necessary attributes (Inferential System) to precede a paradigm element in some activity (PAS) in which the latter could play a part. The indirect reference exemplified by the preceding (in principle, it could be continued indefinitely) gives the system as a whole a descriptive power which is more than a multiplicative function of the descriptive power of its subsystems in spite of the fact that the subsystems deal with many of the same elements and are substantially redundant in terms of information contained in each. The retrieval capacity, and the representational capacity, of the overall system is represented by the power of the system for computing descriptions and not, as might be supposed, merely by the FERS as a simple register of facts. This is consonant with the basic conceptualization of the system. As noted in Appendix Q, reality constraints are given, not by a picture or description of the world, but by the limits of what can be done, and this will hold also for that portion of the world which comprises the substantive domain of the SAM.

4.4 State of Affairs and State of the Art

The State of Affairs Model has been mentioned at times as a program of research, at times as a design, and even, at times, for heuristic purposes, as a functioning system. Certainly, the presentation was not a detailed recipe for constructing a SAM. Ordinarily, in the absence of such a detailed account, one would be inclined to ask, well, can it be done? However, the uncertainty is not quite of this sort. There is no question that in a variety of substantively trivial cases it could be done. The issue is, how well can it be done for a broad range of linguistic data processing needs. The apparent robustness of the C-Space and A-Space procedures in a working setting provide some positive indications here even though the SAM represents a quantum increment in logical complexity.

Most definitely, the SAM represents a program of research and development. We may have some assurance that a SAM is technically feasible, but merely being able to count on some kind of state of the art is quite different from having optimal solutions to the many tasks which must be dealt with. Obviously, progress toward optimal solutions of specific problems requires continued effort. With respect to LDP problems of limited scope, a functioning SAM of any nontrivial sort offers the advantages of in vivo research possibilities as against in vitro studies. Moreover, it does this in a variety of cases which are not normally associated with linguistic data processing. For example, it seems likely that integrating a pattern recognition system with a functioning SAM would augment

the functional capacities of each to a significant degree. Or again, a theory of concept formation, if it had any empirical significance, could be incorporated either as a set of inferential rules to be tested by the inductive system or as the internal case-counting and class forming portion of the inductive system.

Too, it should be clear that the SAM described in the preceding section is not capable of implementing the full system of behavior description and consequently not all of language, either. Using some of the methodological features suggested by Mitchell's study (Appendix R; for example, having transitions computed from parametric values none of which remains constant) it would have been possible to specify a more sophisticated system. However, the SAM described above is here seen as the most primitive of a certain class of information processing systems, and therefore one which could be constructed with minimum risk and relative economy and be used as a basis for further development. For that development, it would seem that even a relatively modest SAM would be a significant resource (e.g., by systematizing means-ends relationships), for a system which processes information in the manner of the SAM would inevitably function to some extent as a problem-solving system just by functioning as an information storage and retrieval system.

5.0 Feasibility Studies

It has been noted previously that the information needs of Users can only sometimes be effectively formulated as subject matter requests and that one of the primary loci of research effort in linguistic data processing lies in identifying and implementing the major forms of information requirements set by Users. Subject matter characterization and conceptual content characterization have been previously identified and developed as two such major forms. The three feasibility studies reported in this section represent preliminary efforts to implement three additional information formats. These are the Means-Ends, Process-Activity, and Part-Whole formats. They are identified as information formats because the information needs of Users are often directly expressed in the following ways: (a) "I want to know how to (or what is required in order to) achieve X"; (b) "I want to know how P fits into process Q"; "I want to know the details of process Q"; "I want to know what elements other than P are required for process Q"; and (c) "I want to know what the parts of Z are"; "I want to know what other parts of Z there are besides A"; "I want to know what relation A and B may or must have if they are distinct parts of Z".

The concepts of part-whole, process-activity, and means-ends are interrelated. The most general of the three would seem to be the part-whole concept, and, indeed, it is so general that there may prove to be no single way of implementing it. Both means-ends and process-activity concepts may be seen as major species of part-whole concepts. A process or activity can be described as a whole whose major parts have a relation of temporal successions. A means-ends pair may be thought of as a whole containing two major parts which may or may not stand in temporal succession. Thus means-ends pairs differ in

general from process-activity concepts. Although the means whereby an end is reached is always behavior, hence an activity, the end need not be a subsequent state of affairs. The Means-Ends feasibility study provides evidence of the importance of distinguishing process concepts and means-ends relationships.

Thus, the three feasibility studies reported below deal in an exploratory fashion with three interrelated concepts which are numbered among the basic information formats described in Section 4. These studies are described in greater detail below.

5.1 The Means-Ends Studies

The natural and most precise form of representation of means-ends relationships, particularly when any substantial degree of complexity is involved, appears to be a "branching tree" graph. In contrast to the obvious advantage of this precise representation, the graphical form has the disadvantages (a) that it requires relatively time-consuming procedures to arrive at a graph, (b) that it is relatively cumbersome for computational processing, and (c) that it is language-tied in the sense that key word indexing is language-tied, and any effort to gain flexibility in this respect is likely to prove excessively costly in terms of both (a) and (b). For these reasons, the possibility of a geometric model (see Section 4.3) for representing means-ends relationships was selected for investigation. A secondary emphasis was placed on investigating the feasibility of using certain simple psychometric procedures for setting up means-ends graphs.

The means-ends project was accomplished in two distinct efforts, the "Case Study" and the "Psychomotric Study". The Case Study was an effort to achieve a rigorous means-ends graph dealing with content representative of the scientific-technical domain. The Psychometric Study was designed to provide a geometric representation of the same content domain as the Case Study. The Means-Ends Study was accomplished principally by Mr. Larry Brittain, of the University of Colorado, in cooperation with Dr. William B. Lovell, who served as consultant-informant.

5.1.1 The Case Study

The primary requirement for the case study was the cooperation of a scientist who was engaged in a goal-oriented project having a substantial degree of complexity and

sequential structure. This requirement was met by a physical chemist engaged in an investigation (second harmonic generation in anisotropic crystals) which required sequential procedures involving the assembly of complex apparatus. The graph-representation of this study, given in detail in Table 5.1.1 B, was the outcome of several hours of interviewing, analysis of interview transcripts, and cross-checking with the chemist. Because it is of some technical importance to have data-collection procedures which are minimally time-consuming and can be carried out in the absence of personal contact with an interviewer, a "Progressive Interview" format was developed with an eye to self-administration by a variety of informants. The interviews with the chemist were conducted as semi-structured interviews, using the Progressive Interview format (Table 5.1.1 A) as the interview structure. The results of the interview (Table 5.1.1 B) are presented in numeral-subheading form rather than literally in graphic form.

5.1.2 The Means-Ends Psychometric Study

The primary aim of the Psychometric Study was to investigate the possibility and potential value of a geometric model for representing means-ends relationships. Thus, the technical approach, with some task-specific modifications, was essentially the same as described previously (Section 4 and RADC-TDR-64-287) for constructing such a model.

The primary modification stemmed from the fact that since the two-place relationship in question was that of means to ends the marginals of the data matrix consisted of means and ends (analogous to the words and subject matter fields in the C-Space and to the objects and properties of the A-Space). The list of means was obtained over several occasions by asking the chemist (see Case Study) and two assistants to identify "things done"

Table 5.1.1A Progressive Interview

1. Please describe your project in terms of the series of events which must occur in order for it to be successful.

2. Which of these events are you positive you already know how to accomplish?

3. Why do you feel uncertain about being able to accomplish the others?

4. At which points along the way will you have to expand your knowledge before you can move ahead to things you already can accomplish with your present knowledge?

5. Regarding these accomplishments, as separate achievements, please describe the nature of each relation which obtains between them.

6. In case some of these achievements are not directly related to other achievements, how are they related to the project itself?

7. Let's take those accomplishments that you feel confident about being able to achieve on the basis of your present knowledge. What, specifically, will have to be done in order to successfully complete the first ... the second ... etc.

8. Now let's look at those accomplishments for which you will have to expand your knowledge. Specifically where will you be able to rely on what you already know?

9. Can you describe what must be done in order to accomplish these things, even though your present knowledge about how to accomplish them is incomplete?

10. Please locate your problem in the social context to which it is appropriate. How is it significant or meaningful? What does it contribute?

Table 5.1.1B Means-Ends Hierarchy

The overriding goal, or end, of this study is <u>to advance scientific knowledge concerning the nature of second harmonic generation in anisotropic crystals</u>. The major subgoals begin this hierarchy.

1.0 Be able to measure the coefficients for second harmonic generation in anisotropic crystals using laser light.

- 1.1 Use a gas laser of known wave length
  - 1.11A Purchase a gas laser of the desired specifications from a commercial source <u>or</u>
  - 1.11B Build a gas laser of the desired specifications <u>and</u>
  - 1.12B Have a power supply for the laser
- 1.2 Be able to detect and measure the weak power levels produced in harmonic generation.
  - 1.21 Use a power ratio measurement technique
    - 1.211 Measure the power of the fundamental frequency and second harmonic frequency simultaneously
  - 1.22 Separate the second harmonic from the noise in the system
    - 1.221 Use a lock-in, phase-sensitive detection system
      - 1.2211 Modulate the signal at 1000 cps
        - 1.22111 Use a rotating wheel modulator or

Table 5.1.1B Means-Ends Hierarchy (Continued)

1.22112 Use an electro-optic modulator or

1.22113 Use a pulse modulator

1.221131 Have a modulator driver

1.2211311 Use a 500 volt oscillator

1.2212 Use a photocell with a voltmeter

1.22121 Use a vacuum tube voltmeter <u>or</u>

1.22122 Use a digital voltmeter <u>or</u>

1.2213 Use a photometer

1.2214 Use a lock-in amplifier

1.222 Filter out the fundamental frequency from the second harmonic frequency

1.2221 Use a series of glass filters

1.2222 Use a solution of copper sulphate

1.2223 Use a spectrometer

1.2224 Use a prism

1.223 Filter out all radiation coming from laser except that at desired wavelength

Table 5.1.1B Means-Ends Hierarchy (Continued)

1.2231 Use a spike filter

1.224 Polarize the radiation coming from the laser at the fundamental frequency

1.2241 Use polarized film

1.2242 Use a calcite crystal

1.2243 Align the polarizer with the laser radiation to have the same polarization

1.225 Eliminate all sources of non-laser light

1.2251 Completely darken the room in which measurements are made

1.3 Use anisotropic crystals

1.31 Determine the shape of crystal needed for the project

1.311 Purchase crystals of the desired specifications from a commercial source <u>or</u>

1.312 Grow crystals of the desired specifications in the lab <u>and</u>

1.313 Orient, cut, polish, and mount laboratory-grown crystals

1.32 Decide which anisotropic crystals are most valuable to measure

1.321 Choose those crystals which are known on the basis of prior information to have appreciable second harmonic generation

Table 5.1.1B Means-Ends Hierarchy (Continued)

1.322 Choose particular crystals about which as much information as possible is known

1.323 Choose particular crystals about which as little information as possible is known

1.33 Crystal placement

1.331 Measure lens to crystal distance

1.332 Measure the orientation of the crystal to the laser beam

1.34 DC polarization

1.341 Apply electrodes to the crystal

1.3411 Evaporate a conductive coating onto the crystal

1.3412 Attach aluminum foil

1.3413 Use crystal in pressure-plate type electrodes

1.342 Construct crystal holder

1.343 Measure DC voltage across crystal

1.4 Generate second harmonics

1.41 Set up varying conditions of radiation energy density within the crystal

1.411 Focus the laser beam in the exact center of the crystal under investigation

Table 5.1.1B Means-Ends Hierarchy (Continued)

1.4111 Use a variable focus lens
<u>or</u>

1.4112 Use a set of fixed lenses

1.412 Focus a spot whose size is known

1.4121 Use a variable focus lens

1.413 Focus on the crystal from a known distance

1.414 Collimate the beam of the gas laser

1.5 Measure the power distribution of second harmonic output

1.51 Take photographs of the second harmonic

1.511 Use a camera

1.512 Use extended range film

1.52 Measure the distribution of exposure in the film

1.521 Use a densitometer <u>or</u>

1.522 Use a scanning photodetector <u>or</u>

1.523 Use a flying spot scanner

1.6 Measure the divergence of second harmonic output

1.61 Measure the power distribution of second harmonic output at varying distances between the crystal and the detection system

Table 5.1.1B Means-Ends Hierarchy (Continued)

1.611 Take photographs of the second harmonic

1.6111 Use a camera

1.6112 Use extended range film

1.612 Measure the distribution of exposure in the film

1.6121 Use a densitometer <u>or</u>

1.6122 Use a scanning photo-detector <u>or</u>

1.6123 Use a flying spot scanner

1.7 Measure the polarization of second harmonic output

1.71 Use a soleil compensator

2.0 Be able to describe the specific conditions under which measurements are made

2.1 Have a quantitative description of the laser beam radiation pattern

2.11 Make a contour diagram

2.111 Measure the power distribution across the laser beam

2.1111 Take photographs of the laser beam

2.11111 Take photographs of the second harmonic

2.111111 Use a camera

2.111112 Use extended range film

Table 5.1.1B Means-Ends Hierarchy (Continued)

2.11112 Measure the distribution of exposure in the film

2.111121 Use a densitometer or

2.111122 Use a scanning photodetector or

2.111123 Use a flying spot scanner

2.112 Measure the actual percentage of modulation introduced by the modulator (same as: determine laser beam modulation pattern)

2.1121 Use an oscilloscope photograph

2.113 Be able to determine the parameters of the Gaussian equation which describes the power distribution across the laser beam

2.1131 Measure the power distribution of the gas laser beam at varying distances

2.114 Measure the power output of the laser

2.1141 Use a beam splitter

2.11411 Know the percentage of power the beam splitter takes off the laser beam

Table 5.1.1B Means-Ends Hierarchy (Continued)

2.1142 Use a diode detector

2.11421 Use a calorimeter

2.11422 Use a thermopile

2.11423 Use a calibrated photodetector

2.11424 Use calibrated film

2.11425 Use calibrated photosensitive paper

2.12 Measure the polarization of the gas laser beam

2.121 Use a soleil compensator

2.13 Measure the convergence of the gas laser beam

2.2 Calculate the non-zero tensor elements of crystal being used

2.21 Know the tensor group of the crystal being used

2.22 Determine which elements of the crystal property tensor are non-zero elements

2.23 Determine the measurement angles necessary to obtain non-zero elements of the crystal property tensor

2.24 Determine coordinate transformations necessary to obtain tensor elements

2.25 Write computer programs to carry out necessary coordinate transformations

Table 5.1.18 Means-Ends Hierarchy (Continued)

2.26 Feed tabulated data to computer and obtain tensor elements (results)

2.3 Know how the axes of the crystal are oriented with respect to the laser beam

2.31 Know the angle at which the crystal surface is cut with respect to the optic axis of the crystal

2.311 Use a polarizing microscope

2.312 Use an internal reflection process

2.4 Know the ordinary and extraordinary refractive index values for the crystal at both the fundamental and harmonic frequencies

2.5 Perform the necessary pre-calibrations of instruments used in the measurement system

2.51 Calibrate the relative sensitivity of the photometer to the fundamental and harmonic frequencies

2.511 Know how the sensitivity of the photometer varies as a function of the temperature of the photocell

2.5111 Be able to measure the temperature of the photocell

2.52 Pre-calibrate the variable focus lens and other lenses to give the desired spot size and focal distance of laser radiation in the crystal

2.53 Pre-calibrate the diode detector (used to measure laser fundamental power)

Table 5.1.1B Means-Ends Hierarchy (Continued)

2.531 Use a radiation standard

2.532 Use a photographic system

2.5321 Use a densitometer

2.6 Determine the thickness of the crystal

2.61 Use absorption measurement

2.62 Use dielectric measurement (capacitance measurement)

2.7 Measure the temperature of the crystal

2.71 Use a thermocouple

2.72 Use a resistance thermometer

2.73 Use a silicon diode bridge

2.74 Use a germanium resistor

2.8 Determine the mode pattern of the gas laser beam

2.81 Use visual inspection

2.9 Determine the dielectric constant of the crystal

3.0 Develop a theoretical account of second harmonic generation

3.1 Decide what theory of solid state can explain the fact that second harmonic generation occurs at one crystal temperature and not at another

3.11 Know the symmetry of the various crystal phases

3.12 Know the class of the crystal for each of its phases

Table 5.1.1B Means-Ends Hierarchy (Continued)

3.13 Know the correlation between the magnitude of second harmonic generation and the class the particular crystal phases belong in

3.14 Relate the potential energy of particular ions in the crystal to the amount of second harmonic generation which occurs in the crystal

4.0 Discover the various conditions under which the phenomenon of second harmonic generation occurs

4.1 Study the phenomenon of second harmonic generation as a function of the temperature of the crystal

4.11 Determine the curve in a crystal phase transition

4.111 Measure the phase transition temperature of the crystal in various ways

4.1111 Use thermodynamic measurement

4.11111 Use a thermocouple

4.11112 Use a resistance thermometer

4.11113 Use a silicon diode bridge

4.11114 Use a germanium resistor

4.1112 Measure the ferro-electric behavior of the crystal in various ways

Table 5.1.1B Means-Ends Hierarchy (Continued)

4.12 Discover the crystal temperature at which an enhancement of second harmonic generation occurs

4.13 Determine whether there are temperature hysteresis effects in the crystal being used

4.131 Be able to control the temperature of the crystal at ranges extending through the Curie temperatures of the crystal

4.2 Try to detect the occurrence of the phenomenon of second harmonic generation in as many different materials (crystals) as possible

4.21 Study inorganic crystals

4.22 Study organic crystals

4.3 Study the amount of second harmonic generated as a function of focal distance and spot size of the laser radiation in the crystal

4.31 Be able to vary precisely the orientation of the crystal axis with respect to the laser beam

4.4 Be able to vary the power of the laser radiation

4.41 Polarize the radiation coming from the laser at the fundamental frequency

4.411 Rotate the polarizer by degrees

4.4111 Use a rotating mount

4.5 Be able to vary the power distribution across the laser beam with a Gaussian distribution

Table 5.1.1B Means-Ends Hierarchy (Continued)

5.0 Write up the results of the experiment

5.1 Describe the results of the experiment in a precise quantitative way

5.11 Obtain a definite record of the results

5.111 Use a strip chart recorder

5.112 Use an oscilloscope

5.113 Use a digital voltmeter print out

or "to be done" in the course of the project. Likewise, the list of ends was obtained by asking them on other occasions to identify "things to be accomplished" in the course of the project. The list of means and ends for the study is presented in Table 5.1.2A. Because of the hierarchical nature of the means-ends structure of the project, most of the items identified as "ends" were also identified as "means". Thus, Table 5.1.2A shows that 70 items were used as both means and ends. Ten additional means unconnected with the project were also added, for purposes of comparison. Two additional ends, which were, in effect, the overall goal of the project, were also used.

The data matrix consisted of ratings of each means with respect to each end. The rating was a rating of the degree of effectiveness of the means with respect to the achievement of the end. Ratings were made by a single informant, the chemist.

This data was transformed into the geometric model, the "Ends Space", presented in Table 5.1.2B. The Ends Space consists of 24 common factors and 13 unique factors, making a total of 37 factors. In addition, the coordinates in the Ends Space were computed for each of the 80 means. These results are also summarized in Table 5.1.2B. In this table each factor of the Ends Space is represented by those ends having a projection of .500 or greater. Immediately below the list of these ends for a given factor is a list of all those means having substantial (3.0 or greater) coordinate values on this factor in the Ends Space. This arrangement was adopted in order to facilitate visual inspection and judgment of the appropriateness of these means to the type of end represented by the factor in question.

In general, the results shown in Table 5.1.2B appear to be a valid representation of means-ends relationships in a geometric model. In this connection, the following points

Table 5.1.2A Means and Ends List

A. Means and Ends

1. Anisotropic crystals
2. Filter gas laser output
3. Modulate gas laser output
4. A spike filter
5. A rotating wheel modulator
6. An electro-optic modulator
7. Establish symmetry and class of a crystal
8. Collimate the beam of a gas laser
9. A variable focus lens
10. A set of fixed lenses
11. Measure the power of a gas laser system
12. A Calorimeter
13. A calibrated photodetector
14. Calibrated film
15. Write computer programs to carry out coordinate transformation.
16. An oscilloscope
17. Determine the mode pattern of a gas laser beam
18. Photographic inspection
19. A scanning photocell

Table 5.1.2A Means and Ends List (Continued)

A. Means and Ends (Continued)

20. Determine which elements of crystal property tensor are non-zero elements

21. Measure the convergence of a gas laser beam

22. Measure the polarization of a gas laser beam

23. Polarized film

24. A soleil compensator

25. Measure the focal distance of the final lens in a system

26. Determine the orientation of a crystal with respect to a laser beam

27. Order X to specifications needed from a commercial source

28. A polarizing microscope

29. A helium-neon gas laser

30. An internal reflection process

31. Determine the thickness of a crystal

32. Specify the cut crystal and necessary orientation of a crystal with respect to a laser

33. Absorption measurement

34. Dielectric measurement

35. Measure the temperature of a crystal

36. A thermocouple

37. A resistance thermometer

Table 5.1.2A Means and Ends List (Continued)

A. Means and Ends (Continued)

38. Determine coordinate transformations necessary to obtain tensor elements of a crystal

39. Measure the power of second harmonic output

40. A phase sensitive detector

41. Measure the power distribution of second harmonic output

42. A microdensitometer

43. A scanning photodetector

44. Measure the power distribution of second harmonic output at varying distances between a crystal and a detection system

45. Measure the divergence of second harmonic output

46. Measure the polarization of second harmonic output

47. Determine laser beam modulation pattern

48. Obtain a graphic record of crystal temperature

49. Obtain a record of laser input and output power

50. A digital voltmeter printout

51. Determine gas laser input and output power distribution

52. A contour diagram

53. A photodiode

54. Measure the power distribution of a gas laser beam

55. Measure the power distribution of a gas laser beam at varying distances between the final lens of a system and a detection system

Table 5.1.2A Means and Ends List (Continued)

A. Means and Ends (Continued)

56. Determine the shape of crystal needed for a project

57. A cubic crystal

58. Determine the dielectric constant of a crystal

59. Determine the DC polarization of a crystal

60. Evaporate a conductive coating onto a crystal

61. Use a crystal in pressure-plate type electrodes

62. Measure DC voltage across a crystal

63. A digital voltmeter

64. A vacuum tube voltmeter

65. Capacitance measurement

66. Measure gas laser power input

67. An oscilloscope photograph

68. Determine the measurement angles necessary to obtain values for non-zero elements of crystal property tensor

69. Feed tabulated experimental data to computer, obtain results

70. A flying spot scanner

B. Additional Means

71. A spectrometer

72. A rheostat

Table 5.1.2A Means and Ends List (Continued)

B. Additional Means (Continued)

73. A clystron power supply

74. Create anti-ferro magnetic resonance

75. Use heliarc welding techniques

76. A germanium resistor

77. Make a magnetic field sweep

78. Put a crystal inside a spectrometer

79. Say, "Gee, I liked that", when a client says something I like

80. Get volunteer subjects over 21 years of age

C. Additional Ends

81. Determine the nature of DC polarization in anisotropic crystals

82. Determine the nature of second harmonic generation in anisotropic crystals

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors

Factor 1. Equipment and Apparatus

.662	A microdensitor
.655	Polarized film
.654	A soleil compensator
.653	A phase sensitive detector
.642	Calibrated film
.641	A flying spot scanner
.640	A spike filter
.638	A variable focus lens
.635	A vacuum tube voltmeter
.635	A thermocouple
.627	A polarizing microscope
.614	A photodiode
.612	A digital voltmeter
.609	An electro-optic modulator
.607	A set of fixed lenses
.592	A resistance thermometer
.579	Order X to specifications needed from a commercial source
.570	A calibrated photodetector
.569	An oscilloscope
.564	A helium-neon gas laser
.537	A scanning photocell
.500	A rotating wheel modulator

Means and Coordinate Values

5.13 Order X to specifications needed from a commercial source

Factor 2. Preparing the Crystal

.920	Determine coordinate transformations necessary to obtain tensor elements of a crystal
.826	Write computer programs to carry out coordinate transformations
.731	Determine which elements of the crystal property tensor are non-zero elements

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 2.	Preparing the Crystal (Continued)
.680	Specify the cut and necessary orientation of a crystal with respect to a laser
.608	Anisotropic crystals
.541	Establish symmetry and class of a crystal
.502	Use a crystal in pressure-plate type electrodes

Means and Coordinate Values

7.11	*Determine which elements of the crystal property tensor are non-zero elements
6.94	*Establish the symmetry and class of a crystal
6.06	*Determine coordinate transformations necessary to obtain tensor elements of a crystal
5.72	*Anisotropic crystals
2.52	*Write computer programs to carry out coordinate transformations
1.65	*Specify the cut and necessary orientation of a crystal with respect to a laser
1.51	A contour diagram
1.51	Determine the measurement angles necessary to obtain values for non-zero elements of crystal property tensor
1.22	An internal reflection process

Factor 3.	Measuring the Power Distribution of Second Harmonic Output of a Gas Laser Beam
.786	Measure the power distribution of a gas laser beam
.760	Determine the mode pattern of a gas laser beam
.753	Measure the convergence of a gas laser beam
.738	Determine gas laser input and output power distribution
.716	Measure the power distribution of second harmonic output

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 3. Measuring the Power Distribution of Second Harmonic Output of a Gas Laser Beam (Continued)

.652	Measure the divergence of second harmonic output
.613	Measure the power distribution of a gas laser at varying distances between the final lens of a system and a detection system
.583	A contour diagram
.570	Measure the power distribution of second harmonic output at varying distances between a crystal and a detection system

Means and Coordinate Values

6.00	A helium-neon gas laser
5.21	Calibrated film
5.17	Collimate the beam of a gas laser
4.80	A scanning photocell
4.43	A calibrated photodetector
4.40	A microdensitometer
4.25	A scanning photodetector
4.24	A digital voltmeter
4.24	A digital voltmeter printout
4.01	A phase sensitive detector
3.84	A flying spot scanner
3.52	Photographic inspection
3.50	*Measure the power distribution of a gas laser beam
3.28	*Determine gas laser input and output power distribution
3.24	An electro-optic modulator

Factor 4. Determine Dielectric Properties of the Crystal

.871	Determine the thickness of a crystal
.850	Determine the dielectric constant of a crystal

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 4. Determine Dielectric Properties of the Crystal (Continued)

.679	Dielectric measurement
.504	Capacitance measurement

Means and Coordinate Values

6.96	Measure the polarization of a gas laser beam
6.59	Determine which elements of crystal property tensor are non-zero elements
5.72	Calibrated film
5.32	Determine laser beam modulation pattern
4.86	Measure the temperature of a crystal
4.68	A calibrated photodetector
4.39	A Photodiode
4.33	Measure the power distribution of a gas laser beam at varying distances between the final lense of a system and a detection system

Factor 5. Get a Crystal of the Proper Shape

.805	Determine the shape of crystal needed for a project
.664	Order X to specifications needed from a commercial source

Means and Coordinate Values

6.13	Establish symmetry and class of a crystal
6.07	*Determine the shape of crystal needed for a project
5.56	Specify the cut of crystal and necessary orientation of a crystal with respect to a laser
4.11	Anisotropic crystals
2.81	*Order X to specifications needed from a commercial source

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 6. Achieve Known Gas Laser Modulation Pattern

.747	Modulate gas laser output
.673	Determine gas laser modulation pattern

Means and Coordinate Values

6.16	*Modulate gas laser output
5.72	A helium-neon gas laser
5.72	Order X to specifications needed from a commercial source
4.98	An electro-optic modulator
4.23	A rotating wheel modulator
3.02	*Determine gas laser modulation pattern

Factor 7. (Overall Goal of the Experiments)

.755	Determine the nature of second harmonic generation in anisotropic crystals
.644	Determine the nature of DC polarization in anisotropic crystals
.607	Feed tabulated data to computer and obtain results

Means and Coordinate Values

(Because Factor 7 corresponds to the overall goal of the experiment, all means except three had substantial coordinate values on this factor. Below are listed the 11 means having the highest coordinates and also three means which had zero coordinates.)

.578	Measure the power of a gas laser system
.578	Establish symmetry and class of a crystal
.578	Obtain a record of laser input and output power
.578	Determine which elements of crystal property tensor are non-zero elements

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 7. (Overall Goal of the Experiments) (Continued)

Means and Coordinate Values (Continued)

.578 Anisotropic crystals
.578 Specify the cut of crystal and necessary orientation of a crystal with respect to a laser
.578 Determine the orientation of a crystal with respect to a laser beam
.578 Dielectric measurement
.578 Determine the dielectric constant of a crystal
.578 Measure gas laser power input
.578 Determine the measurement angles necessary to obtain non-zero elements of crystal property tensor

.000 An internal reflection process
.000 A resistance thermometer
.000 A cubic crystal

Factor 8. Achieve Filtered Gas Laser Output

.632 Filter gas laser output
.401 A spike filter
.375 A helium-neon laser

Means and Coordinate Values

.556 *Filter gas laser output
.492 *A helium-neon laser
.492 Order X to specifications needed from a commercial source
.366 *A spike filter

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 9. Establish Crystal Temperature

.820	Obtain a graphic record of crystal temperature
.764	Measure the temperature of a crystal

Means and Coordinate Values

6.24	Order X to specifications needed from a commercial source
4.32	An oscilloscope
4.13	Determine laser beam modulation pattern
3.70	A resistance thermometer
3.67	Modulate gas laser output
3.67	A helium-neon gas laser
3.4[illegible]	A spike filter
3.22	An electro-optic modulator
3.22	An oscilloscope photograph
3.07	Anisotropic crystals
3.06	Determine the shape of crystal needed for a project
3.06	*Obtain a graphic record of crystal temperature

Factor 10.

.704	An oscilloscope photograph
.501	Write computer programs to carry out coordinate transformations

Means and Coordinate Values

6.13	*An oscilloscope photograph
5.42	An oscilloscope
5.42	Order X to specifications needed from a commercial source
4.02	Collimate the beam of a gas laser
3.32	A Photodiode

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 11.

.721	Measure the polarization of second harmonic output
.595	Determine the orientation of a crystal with respect to a laser beam

Means and Coordinate Values

5.89	*Determine the orientation of a crystal with respect to a laser beam
5.54	Anisotropic crystals
5.54	A helium-neon gas laser
4.19	*Measure the polarization of second harmonic output
3.73	Determine which elements of crystal property tensor are non-zero elements
3.73	Specify the cut of crystal and necessary orientation of a crystal with respect to a laser
3.73	Order X to specifications needed from a commercial source
3.71	Determine the measurement angles necessary to obtain values for non-zero elements of crystal property tensor
3.59	A digital voltmeter
3.13	A photodiode

Factor 12.

.657	Determine the measurement angles necessary to obtain values for non-zero elements of crystal property tensor
.579	An internal reflection process

Means and Coordinate Values

5.81	Determine the orientation of a crystal with respect to a laser beam

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 12. (Continued)

Means and Coordinate Values (Continued)

4.58 *An internal reflection process
3.62 *Determine the measurement angles necessary to obtain values for non-zero elements of crystal property tensor
3.23 Establish symmetry and class of a system

Factor 13.

.552 Measure the polarization of a gas laser beam

Means and Coordinate Values

6.66 *Measure the polarization of a gas laser beam
5.89 A helium-neon gas laser
5.89 Order X to specifications needed from a commercial source
4.35 Polarized film
4.35 A calibrated photodetector
4.35 A soleil compensator
4.35 A Photodiode
4.35 A phase sensitive detector
3.58 A set of fixed lenses
3.58 A digital voltmeter

Factor 14.

.650 Collimate the beam of a gas laser
.357 A variable focus lense
.328 A helium-neon gas laser

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 14. (Continued)

Means and Coordinate Values

5.50	*Collimate the beam of a gas laser
5.75	*A helium-neon gas laser
5.75	Order X to specifications needed from a commercial source
4.25	A variable focus lense

Factor 15.

.654	A scanning photodetector
.6[illegible]5	A Scanning photocell

Means and Coordinate Values

5.38	*A scanning photocell
4.77	Order X to fit specifications needed from a commercial source
3.39	*A scanning photodetector

Factor 16.

.666	Measure DC voltage across a crystal
.637	Determine the DC polarization of a crystal
.324	A digital voltmeter printout

Means and Coordinate Values

5.52	Determine gas laser input and output power distribution
5.16	Establish symmetry and class of a crystal
5.16	Anisotropic crystals
5.16	Determine the shape of crystal needed for a project

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 16. (Continued)

Means and Coordinate Values (Continued)

5.16	Determine the measurement angles necessary to obtain values for non-zero elements of crystal property tensor
4.50	Evaporate a conductive coating onto a crystal
4.49	A digital voltmeter
3.83	Measure the temperature of a crystal
3.47	An oscilloscope
3.43	Use a crystal in pressure-plate type electrodes

Factor 17.

.740	Photographic inspection
.519	Calibrated film

Means and Coordinate Values

8.00	*Photographic inspection
7.22	*Calibrated film

Factor 18.

.705	Measure gas laser power input
.702	Measure the power of a gas laser system
.623	Obtain a record of laser input and output power

Means and Coordinate Values

5.79	*Measure gas laser power input
5.78	*Measure the power of a gas laser system
5.43	*Obtain a record of laser input and output power
5.43	A helium-neon gas laser

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 18. (Continued)

Means and Coordinate Values (Continued)

4.73	A calibrated photodetector
4.73	A digital voltmeter printout
4.73	A digital voltmeter
4.38	Order X to specifications needed from a commercial source
4.03	A photodiode
4.03	Filter gas laser output
4.02	Calibrated film
4.02	A scanning photodetector
4.02	A set of fixed lenses
4.02	A phase sensitive detector
3.67	A vacuum tube voltmeter
3.32	An electro-optic modulator
3.31	An oscilloscope photograph

Factor 19.

.657	Measure the focal distance of the final lens in a system
.529	A set of fixed lenses

Means and Coordinate Values

5.32	*A set of fixed lenses
5.09	Order X to specifications needed from a commercial source
3.95	*Measure the focal distance of the final lense in a system
2.23	A vacuum tube voltmeter
2.23	A photodiode

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 20.

.629	Absorption measurement

Means and Coordinate Values

7.22	*Absorption measurement
6.38	Anisotropic crystals
4.70	An oscilloscope
3.86	A calibrated photodetector

Factor 21.

.720	Establish symmetry and class of a crystal
.595	A polarizing microscope

Means and Coordinate Values

5.80	*A polarizing microscope
4.18	*Establish symmetry and class of a crystal
3.72	Anisotropic crystals

Factor 22.

.570	A calorimeter
.530	A resistance thermometer

Means and Coordinate Values

4.11	*A resistance thermometer
3.72	Order X to specifications needed from a commercial source
3.02	*A calorimeter

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 23.

.655 A digital voltmeter printout

Means and Coordinate Values

5.74	*A digital voltmeter printout
5.08	Specify the cut of crystal and necessary orientation of a crystal with respect to a laser
5.08	Determine the shape of crystal needed for a project
5.08	A digital voltmeter
5.08	Order X to specifications needed from a commercial source
3.77	A calibrated photodetector
3.12	A scanning photodetector
3.12	Evaporate a conductive coating onto a crystal
3.12	Use a crystal in pressure-plate type electrodes
3.12	Modulate gas laser output
3.12	Measure DC voltage across crystal

Factor 24.

.800 Evaporate a conductive coating onto a crystal

Means and Coordinate Values

6.90	*Evaporate a conductive coating onto a crystal
6.10	Anisotropic crystals
6.10	Specify the cut of crystal and necessary orientation with respect to a laser

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 25.

.710 A rotating wheel modulator

Means and Coordinate Values

6.18 *A rotating wheel modulator
4.05 Order X to specifications needed from a commercial source

Factor 26.

.640 An electro-optic modulator

Means and Coordinate Values

5.62 *An electro-optic modulator
4.98 Order X to specifications needed from a commercial source

Factor 27.

.660 A variable focus lens

Means and Coordinate Values

5.78 *A variable focus lens
5.12 Order X to specifications needed from a commercial source

Factor 28.

.750 A calorimeter

Means and Coordinate Values

6.50 *A calorimeter

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 28. (Continued)

Means and Coordinate Values (Continued)

4.25 A resistance thermometer
3.50 Measure the power of a gas laser system

Factor 29.

.690 Polarized film

Means and Coordinate Values

6.02 *Polarized film
5.33 Order X to specifications needed from a commercial source

Factor 30.

.710 A soleil compensator

Means and Coordinate Values

6.18 *A soleil compensator
5.47 Order X to specifications needed from a commercial source

Factor 31.

.790 An internal reflection process

Means and Coordinate Values

6.82 *An internal reflection process

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 32.

.660 A thermocouple

Means and Coordinate Values

5.78 *A thermocouple
5.19 Order X to specifications needed from a commercial source

Factor 33.

.670 A phase sensitive detector

Means and Coordinate Values

5.86 *A phase sensitive detector
5.19 Order X to specifications needed from a commercial source

Factor 34.

.640 A microdensitometer

Means and Coordinate Values

5.62 *A microdensitometer
4.98 Order X to specifications needed from a commercial source

Factor 35.

.980 A cubic crystal

Means and Coordinate Values

8.00 *A cubic crystal

Table 5.1.2B Ends Space Factors and Coordinates of Means With Respect to These Factors (Continued)

Factor 36.

.640 Capacitance measurement

Means and Coordinate Values

5.62	*Capacitance measurement
4.34	Evaporate a conductive coating onto a crystal
4.34	A digital voltmeter printout
4.34	Order X to specifications needed from a commercial source
3.70	A vacuum tube voltmeter

Factor 37.

.740 A flying spot scanner

Means and Coordinate Values

6.42	*A flying spot scanner
5.68	Order X to specifications needed from a commercial source

may be noted.

(a) By inspection, the means listed under each factor appear to be generally appropriate to the type of end represented by that factor. The greatest difficulty in this connection is provided by the widespread appearance of means 51, "Order X to specifications needed from a commercial source". Although it is entirely understandable that this means would rank high with respect to many ends, particularly those ends primarily representing items of apparatus, it is not entirely plausible as the most appropriate means with respect to Factor 9, which was described as "Establish Crystal Temperature".

(b) The one "general" factor is Factor 7, which is defined by the two major goals of the project. On Factor 7, all the means (except 3) among the 70 have appreciable coordinate values. In contrast, coordinate values of zero for the various means are more common than otherwise for the other factors.

(c) The means with the highest coordinates on Factor 7 are recognizable as relatively proximal means (in terms, e.g., of the hierarchy derived from the case study).

(d) The Ends factors which represent equipment and apparatus in general have no means with substantial coordinates other than means 51, "Order X to specifications . . . ", and occasionally, other items of equipment. This corresponds to the generally low level of equipment items in the hierarchy derived from the case study.

5.1.3 Comparison of the Case Study Hierarchy with the Psychometric Study Results

Although the geometric model of means-ends relationships constructed in the Psychometric study does appear to be a generally valid representation, it does not reflect in any simple way the hierarchical relationships delineated on the basis of the case study.

It might have been expected, for example, that many of the ends which define (have the highest projection on) Ends Space factors would correspond to the major subheadings in the means-ends hierarchy. In fact, this was not the case. One reason may be simply that there were no means or ends in the Psychometric study which could be identified with any of the major subgoals (1.0, 2.0, 3.0, 4.0, 5.0) of the means-ends hierarchy. However, there was no tendency at the other levels for the factor-defining ends to be high in the means-ends hierarchy. For example, at level two (items with two-digits, e.g., 1.1) two factor-defining ends were found out of a total of seven cases where a correspondence could be established between items in the hierarchy and items in the Psychometric Study list of ends. This is a ratio of .28. Corresponding figures for levels three (e.g., 1.11), four (e.g., 1.111), five and six are, respectively, 6/20 (.30), 6/18 (.33), 3/11 (.27), and 0/8 (.00). Thus, the factor-defining ends in the Psychometric Study are relatively evenly spread throughout the means-ends hierarchy except, as might be expected, at the lowest level of the hierarchy.

On the face of it, simple means-ends relationships cannot be equated with a particular position in a means-ends hierarchy. This is already shown by the fact that certain means-ends units appeared in more than one position in the hierarchy, and the contrast between the results of the two studies is consistent with this fact. In this connection, it should be noted that although the means and ends of the Psychometric Study were selected as being parts of the Case Study project, the effectiveness judgments were made in regard to each means-end pair per se and not merely to the means-end pair in the context of the project.

Thus, the geometric model may be regarded as the approximative codification of a potentially unlimited number of simple means-end relationships <u>of the kind which must be selectively assembled in order to reconstruct a complex means-end hierarchy</u>, and the latter may be regarded as a logical (and technical) hybrid which could be generated or reconstructed from the resources of (a) a geometric model and (b) a part-whole structure. Such a reconstruction would, for example, be available for redundancy checking in an operating system (see Section 4.3) which included all three.

5.1.4 Psychometric Method for Hierarchy Construction

An additional psychometric procedure was introduced in an attempt to reproduce the means-ends hierarchy with greater experimental economy. Each means-end rating (of effectiveness) was accompanied by another rating in which the rater specified whether that means to that end was a <u>direct</u> means or an <u>indirect</u> means (assuming a non-zero effectiveness rating). The expectation was that the linking together of direct means to ends would reproduce the means-end hierarchy, and that this result could be cross-checked in terms of the rated indirect means. It still appears that such a procedure may be feasible, although it showed little success in the present study. One reason for this failure, as noted, was that many of the more general subgoals in the hierarchy were not represented in the psychometric study. Another reason, also noted above, was that the psychometric judgments were not restricted to the context of the project in question.

A more fundamental difficulty, however, is suggested by patterns of ratings in which Q is a means to P, P is a means to R, and R is a means to Q. Such a pattern occurred more than once, and this posed insuperable problems for any effort to generate a hierarchy

automatically from the "direct" and "indirect" ratings. An examination of the intractable cases provides fairly convincing evidence that the rater had failed to distinguish means-ends relationships from means-ends activity. Thus, for example, item 15 (Feed tabulated data to a computer and obtain results) was rated as a means to item 48 (Measure the divergence of second harmonic output). This is intelligible since 15 gives the numerical values which constitute the achievement of 48. On the other hand, item 48 was rated as a means to item 15. This, too, is intelligible, since the activity (manipulating apparatus) involved in 48 preceded and was a precondition for the activity of 15.

Since the relevant distinctions w   e not incorporated in the instructions for making the ratings, and since they are distinctions which we commonly have little occasion to make, it is hardly surprising that the rater should have failed to follow them in his ratings. The discussion in Section 4 and Appendix Q are of some help here in clarifying the issue: The achievement (outcome) of purposive activity (behavioral processes) has the logical status of a state of affairs, and it is because the latter concept is logically more complex than the concept of a process that we cannot in general equate means-ends relationships with the processes which bring about the ends.

In the light of the present explanation of the failure of the psychometric rating procedure to duplicate the means-end hierarchy, there appears to be a substantial possibility that a procedure of this sort will prove to be an effective data collection device.

5.1.5 Summary of the Means-Ends Study

A means-ends hierarchy was developed for a representative scientific task. A geometric model for the same domain appears to be a generally valid representation of the

simple means-end relationships. The geometric model did not preserve the hierarchical structure to any substantial degree. This result is consistent with the methodological differences between the two approaches, but in part it appears to be a consequence of experimental factors which can be modified. Likewise, the failure of the psychometric ratings to duplicate the interview-based hierarchy may well be only temporary.

The successful representation of means-ends relationship in hierarchical and in geometric form in the present study is evidence of the technical feasibility of employing this double representation as an information format in a functioning LDP system, at least on an experimental basis.

5.2 The Process-Activity Study

Perhaps the simplest way of characterizing a process is by reference to transition rules 4 and 6 in Appendix Q: "A process is a continuous change in a state of affairs," and "A process divides into shorter processes". The paradigm cases of identifiable and repeatable processes will have other features in addition: (a) they can be identified independently of initial conditions and outcomes; (b) they can be interrupted, with specifiable or observable consequences; and, as implied by rule 4, (c) a process occupies a finite period of time.

The ideal case of describing a process is generally considered to consist of giving a mathematical formula which expresses the state of affairs as a joint function of initial conditions and elapsed time, t, for any value of t. Such a process would also be a determinate process. However, for the general case, which includes behavior processes, formulas of this sort are not available. The present study dealing with process and activity concepts represents an analytic effort to formulate procedures for representing processes of a non-determinate sort, i.e., processes for which a continuous formula is not known, since it may be expected that determinate processes are relatively easily represented if sufficient information is available.

The basis for representing a process is provided by four of the transition rules presented in Appendix Q:

Rule 4. A process is a continuous change in a state of affairs.

Rule 6. A process divides into shorter processes.

Rule 8. The initiating or terminating of a process is an event.

Rule 7. The occurrence of an event is a state of affairs.

5.2.1 Simple Process Representation

The representation of a process is carried out in the following way:

(a) First, the process as a whole must be identifiable. That is, the process is one whose occurrence can be established, and in the paradigm cases, its occurrence is established by observation. The occurrence of a process is represented by representing the change in state of affairs corresponding to that occurrence.

(b) Second, the process is divisible into stages, or sub-processes (if it is not, then no more than (a) is required).

(c) Third, each sub-process is represented as in (a), i.e., by the change in state of affairs corresponding to the occurrence of that sub-process.

(d) In general, therefore, a process is represented as a succession of changes in a state of affairs, and the representation requires as ingredients only the representation of those states of affairs the changes of which constitute the occurrence of the process. The representation of such states of affairs in turn involves the representation of the constituents (primarily objects) of those states of affairs and at least some of the relationships among those constituents.

5.2.2 Complex Process Representation

The preceding account is subject to complications of the following sorts:

(a) The division into stages may be carried out at various degrees of generality or specificity. As illustrated in the example below, one may have a small number of gross divisions, each of which is susceptible of division into some number of smaller divisions, each of

which etc. It is important to note that each division, of whatever degree of specificity, carries the identifiability requirement mentioned above. This requirement provides the methodological solution to the problem of giving an explicit and finite representation to something that is "in principle" infinitely divisible, for the consequence is that divisions are made neither arbitrarily nor ad infinitum, nor do they need to be. Rather, those divisions which can be made in accordance with the identifiability requirement will exhaust (at any given point in our social history) the information value of the occurrence of the process in question. Because the representation of the process is "anchored at the top" in the occurrence of the whole process rather than being generated continuously from left to right along a time axis, the representation need be carried only at whatever degree of specificity is required on a given occasion.

(b) Even when we restrict ourself to the finite number of divisions which we have any use for, the representation of a process is not a matter of simple left to right generation. Rather, the existence of alternative ways of making a state-to-state transition, the further options which depend on these alternatives (e.g., the number of subdivisions of an A to B sub-process may depend on which way of making the A to B transition is involved), and the contingencies and correspondences which hold among alternatives at different stages combine to require a representation having at least the complexity of a branching tree graph augmented by contingency rules..

(c) The interruption and resumption of processes present certain complexities. One of the issues here is whether the process in question can be interrupted and resume at all. A characteristic feature of deterministic processes is that they cannot be interrupted and

resume, but rather, an interruption requires that the process be initiated again. Anything in the nature of a trajectory has this feature, for example. Likewise, a piece of machinery, when set into operation cannot be interrupted and then resume, but rather, it must be restarted; an "idling" mechanism permits functional interruptions, but that is different from the interruption of the machine operation. The general case of process discussed here may be thought of as processes under a functional description under which "idling" and therefore resumption are possible. (The drawback in thinking of "functional" descriptions here is that it suggests that there is a more basic case which is "real" and not merely "functional", and the obvious candidates for "real" are the left to right deterministic kind - see Appendix Q.)

Certainly, many common cases of activities (behavior processes) exhibit the feature of interruption and resumption to a great degree. Such activities as preparing something, building something, or supervising a group, for example, provide clear cases of bringing task A to a certain point of completion, beginning task B and bringing it to a certain point, then resuming task A, only to take time out to deal with unrelated task C, etc. On the other hand, resumption can occur only with interruptions which occur at the division points corresponding to identifiable stages in the process and interruptions at any other point will generally require resumption from the beginning of the stage in which the interruption occurs. This is because the failure to subdivide a given process more finely then we do gives the smallest units a status akin to events (see Limiting Case 4, Appendix Q), i.e., either they happen or they don't.

In general, even where interruption-resumption is possible, there is a limit to the

length of the interruption following which resumption is possible at all and another, shorter period following which resumption would not be expected. Within the scope of activity description, actual or possible interruption could be represented by reference to actual or possible interpolated activities. Such a description would be of limited utility, however, unless interruption intervals could be compared and represented as longer, shorter, equal, etc. This is accomplished by selecting a conventional, standard activity which contains repetitive, identical stages which can be counted and thereby represent longer or shorter intervals. It might seem that this method of representing intervals is unnecessarily round-about and could be more effectively replaced by reference to a time interval as normally measured. This is not an additional option, however. Clearly, one of the most obvious choices for a standard, repetitive activity is the activity of a clock.

(d) A further complication is that two processes may occur not merely simultaneously, but in virtue of the same set of events (state transitions). For example a state transition which is describable simply as "achieving B" may be identical with one which is describable as "preventing Q". Moreover, the overlap may be only partial. And the selection from among the options available (see (b) above) may itself qualify as a separate process. This is frequently the case with respect to behavior processes. For example, if a wife prepares dinner half an hour late, and if she then serves well-done steak to a husband who likes it rare, then two activities may be identified here, i.e., A and B dining, and A expressing hostility toward B. Standard activities, such as dining, provide the setting and the opportunity for non-standard activities such as motivated behavior in much the same way that the operational mechanisms of a machine provide the setting and opportunity for such

"functional" processes as "computing", "Idling", and "computing again".

Since the occurrence of a process may be represented as a state to state transition, the representation of simultaneous processes may be accomplished by identifying particular states of affairs or transition sequences which qualify under more than one description. In general, it may be expected that to accomplish this may require rather more detailed process characterizations than would be necessary for most other purposes. For example, to establish that the case of dining, above, was also a case of emotional behavior would require not merely (1) the identification of certain sub-processes as elements in a dining sequence, but also (2) a characterization of these sub-processes as a selection from the options provided by a branching tree process diagram for dining, and in addition, (3) a characterization of that selection by reference to relevant standards (it was late, it was well-done, late dinner was infrequent) of appropriateness and frequency.

The need for fine-grained representation of a large number of items having the complex logical structure of a branching tree graph presents the problems mentioned in connection with means-ends relationships, i.e., problems of data collection for achieving those representations and problems of cumbersome computational processing. The methodological solution, following the logic of behavior description, is to divide the problem into two parts, i.e., (1) representation of a moderately small number of paradigm processes of a relatively complex sort, but in skeletal, or schematic form, and (2) representation of a great variety of simple process-inclusion relationships which could be used either to fill in details, including options, in the complex schemata or to construct a new complex schema. The latter might be best accomplished by a geometric model, similar to the Ends Space

described in Section 5.1 or by a part-whole (inclusion relationship) system of representation. In either case, the combined approach would be consistent with an LDP system which depended primarily on information generating capacity rather than large storage and rapid access. Perhaps it would be more realistic to say that a combination approach may be the only way to bring the requirements of linguistic data processing into the range of storage and access time now available, for certainly, a prototype such as described in Section 4 would require a great deal of storage and as rapid access as possible.

5.2.3 Illustrative Case

The following is a partial illustration of a branching tree representation of a familiar process, i.e., the activity of dining. A behavior process is used because on the whole, behavior processes readily exhibit the features discussed above as the "general case" of process, in contrast to the special case where further division is always possible. As in the case of the Means-Ends hierarchy, the activity diagram is presented in Table 5.2.3 A in numbered subheading form.

The activity diagram is limited in three important respects. The first is that it is not developed in complete detail throughout, since it is intended to be illustrative only. At some level of analysis it appears to be most practical to introduce tables of values into the activity diagram (e.g., 1.111 to 1.11 N), with an open-end or "wastebasket" category. Second, contingency rules are not stated, in part, because of the lack of detail. The third limitation is that the activity diagram represents only the divisions of the overall process and only crudely and incompletely represents the total set of elements and interrelationships (i.e., the states of affairs) which are involved in the transitions.

A more detailed account of activity analysis as a form of behavior process description is found in Appendix S.

Table 5.2.3 A   Activity Diagram

0. Dining
  1.0 Meal preparation
    1.1 Dish preparation
      1.11 Remove food and equipment from storage
        1.111 Remove from cupboard <u>or</u>
        1.112 Remove from refrigerator <u>or</u>
          .
          .
          .
        1.11N Remove from other storage place
      1.12 Unpackage
        1.121 Unwrap
        1.122 Unbox
          .
          .
          .
        1.12N Remove other packaging material
      1.13 Assemble food and equipment
      1.14 Alter state of food
        1.141 Cook
        1.142 Blend
        1.143 Heat
          .
          .
          .
        1.14N Alter state in other relevant way

        Options: At any point, go back to 1.1 and start with new item on list, carry this up to any point up to 1.14N, then resume interrupted activity

    1.2 Dishing up
      1.21 Assemble serving equipment and prepared food
        1.211 Assemble individual equipment (e.g., dishes)
        1.212 Assemble common equipment (e.g., bowls, salt shaker)
      1.22 Apportionment
        1.221 Apportion for individual 1
          1.2211 Apportion dish 1
          1.2212 Apportion dish 2
            .
            .
            .
          1.221N Apportion dish N
        1.222 Apportion for individual 2
          .
          .
          .
        1.22N Apportion for individual M

Table 5.2.3 A Activity Diagram (cont.)

Option: Apportion only the first K dishes (KCN) at this time
Option: Interrupt at any point in 1.22, return to 1.21, complete 1.21, and resume in 1.22

1.23 Serving
 1.231 Serve individual 1
  1.2311 Serve dish 1
  1.2312 Serve dish 2

  1.2312 Serve dish N
 1.232 Serve individual 2

 1.23M Serve individual M

Option: Serve by dishes rather than individuals or any combination of dishes and individuals

2.0 Table activity
 2.1 Preparation
  2.11 Diners preparation elsewhere (e.g., wash hands)
  2.12 Diners move to dining positions

Option: Add 2.13

  2.13 Any initial ritual or ceremony
 2.2 Eating (parallel for all diners)
  2.21 Apportion bite-size
  2.22 Transfer to mouth
  2.23 Chew, swallow, bite, etc.
 2.3 Repeat 2.2
 2.4 Completion of eating
  2.41 Food consumed or
  2.42 Any gesture signifying completion

Option: Resume dishing up at 1.22 K + 1, complete 1.22N, resume at 2.2

3.0 Cleaning up
 3.1 Remove equipment to cleaning location

Option: 3.2

Table 5.2.3 A   Activity Diagram (cont.)

3.2 Store remaining food
3.3 Clean equipment
3.4 Store equipment
3.5 Dispose of excess food
3.6 Clean dining locale

5.2.4 Summary of the Process-Activity Study

A logical and methodological basis for the computer implementable representation of process concepts was presented. The following features are present.

(a) The basis is given by the formal concepts of behavior description, and particularly the "object", "process", "event", and "state of affairs" concepts.

(b) The problem of giving a finite representation to processes when the latter cannot be represented by a mathematical formula is dealt with.

(c) The problem of complexity and quantity of detail in representing a collection of distinguishable processes is dealt with by proposing a combination of paradigmatic complex activity schemata and a system for representing a variety of simple process-inclusion relationships.

(d) The latter also serves to distinguish the general cases of means-ends phenomena and process-activity phenomena. The latter are identifiable, repeatable, characterized by known stages, and are practiced. The former are potentially unique, being built up as a sequence of identifiable, simple processes, not in conformity with an existing activity schemata, but by reference to a final state of affairs (the goal).

(e) An illustrative example of dining as an activity is presented.

(f) In addition to material previously referred to in Appendix P and Q, a discursive background account of activity analysis as a form of behavior description is given in Appendix S.

(g) Computer implementation of the activity analysis of dining was not attempted, since the major problem in this regard is taken to be the implementation of a variety of process con-

cepts in some substantive domain and in an operational setting, as indicated in Section 4. However, Appendix R is presented as an example of the computer implementation of the concepts of behavior description. In particular, the study described in Appendix R illustrates the drawing of conclusions by an observer when the observations are necessarily insufficient data for drawing those conclusions. As such it may be regarded as a prototype for a state of affairs model as well as a study of "process". The study also illustrates the use of "wastebasket" categories as a requirement for a non-omniscient observer.

5.3 Part-Whole Study

As indicated above, the concept of part-whole relationship is of such generality and includes such disparate species of concept that its implementation in linguistic data processing may have to be accomplished separately for its major divisions. Some of the work previously described is relevant to the general problem of implementing part-whole concepts. For example, the Attribute Space (RADC-TR-65-314) contains a subspace, the "Category Space", which deals with the classification of wholes. The Process-Activity Study deals with temporal wholes. The Means-Ends Study deals with state-of-affairs constituents. Some aspects of the part-whole problem, e.g., class membership and geometric (physical object) inclusion, appear to be most effectively dealt with in an operational setting since some form of state of the art solution is always available.

Thus, the present part-whole study deals with one of the remaining basic aspects of the general part-whole problem, namely the representation of the relationships among a set of elements which they have by virtue of being parts of a given whole.

There is also a general policy, developed throughout the present report, of looking for combinations of analytic and geometric subsystems for implementing information formats. Thus, the present part-whole study is an investigation of the feasibility of constructing a geometric model for representing part-part relationships.

The primary requirements for a subject of study were (a) a "natural" whole, having (b) readily distinguishable elements (c) having relationships to one another which are relatively complex but also (d) can be ascertained with a good deal of confidence. As with feasibility studies in general, the problem was to locate a subject which would be suf-

ficiently complex to provide a genuine test without being so complex as to provide a substantive problem rather than a technical-methodological one. In this light, the "whole" chosen for study was a social group, the "family", and the relationships in question were the relationships among family members. The choice was responsive to each of the requirements given above.

Thus, the present study was an attempt to construct a geometric model for representing interpersonal relationships among family members per se in an abstract ("typical") family.

5.3.1 Procedures

As described previously, the construction of a geometric model requires a two-place relationship which defines the marginals of a data matrix (i.e., one marginal consists of first-place members and the other of second-place members) and the nature of the data (the degree to which the relationship holds between a first-place member and a second-place member). In the present study the question was whether a given relationship holds between family member A and family member B. For most purposes, including the present one, "Person A has relationship R, with Person B" may be paraphrased as "Person A typically engages in interaction I, with Person B". Thus, for the data matrix, first-place members consisted of A-B family pairs (e.g., "A father --- his younger son"); second-place members consisted of forms of interaction I, and the relationship was one of typicality. The logical form of the data was therefore "The degree to which I is typical of A with respect to B is equal to N", with N being the number appearing in the data matrix.

The procedure for selecting A-B pairs involved defining a paradigm case family,

taking all pairs of family members, and in addition taking a number of non-family members and selectively combining each with members of the family. The paradigm case family consisted of father, mother, older son (about 17 years), older daughter (about 17 years), younger son (about 7), and younger daughter (about 7). Non-family members included a policeman, a criminal, a friend, a neighbor, a college professor, and an elementary school teacher. The complete list of 84 A-B pairs is given in Table 5.3.2 B.

The procedure for selecting interactions was more complex, primarily because the number and type of possible interactions among persons is extremely large even if the choice is restricted to those which are well codified in language. As in the Attribute Space study (RADC-TR-65-314), the primary mode of solution was to categorize various forms of interaction and select paradigm cases from each category. The result was a stratified sample from possible human interactions. Categorization was performed independently by two investigators. Only minor differences existed between the two categorizations, and these were resolved by consultation. In addition, items were drawn from two standard psychological sources, i.e., H. A. Murray's list of Needs, and G. Allport's list of Traits. The result was the list of 84 interactions given in Table 5.3.1 A. The adequacy of the categorization was tested by selecting one hundred interpersonal verbs from Webster's Collegiate dictionary in a quasi-random manner and attempting to assign each of them to one of the categories. No difficulty was found in making these assignments, nor was there any appreciable disagreement between the two judges making the assignments. Thus, the 84 interactions may be considered to be a reasonable approximation of exhaustive coverage (in scope, not detail) of possible interactions.

Table 5.3.1 A   List of Interactions

1. Cooperates with
2. Agrees with
3. Is protected by
4. Evaluates
5. Asks permission of
6. Is indulged by
7. Is courteous to
8. Wakes up
9. Is dependent upon
10. Is critical of
11. Isolates himself from
12. Informs
13. Protests to
14. Attacks
15. Encourages
16. Assists
17. Abhors
18. Burdens
19. Acts friendly to
20. Disagrees with
21. Ignores
22. Alienates
23. Lies to
24. Disciplines
25. Imitates
26. Is patronizing to
27. Hides things from
28. Is assertive with
29. Admires
30. Impresses
31. Confides in
32. Aspires to be like
33. Is condescending to
34. Benefits from
35. Is more ambitious than
36. Is awed by
37. Rejects
38. Is accountable to
39. Works with
40. Is more competitive than
41. Acts lovingly towards

Table 5.3.1 A List of Interactions (cont.)

42. Bothers
43. Argues with
44. Is independent of
45. Is passive towards
46. Rebels against
47. Eats with
48. Is not restrained by
49. Avoids
50. Frets about
51. Disavows
52. Is demanding of
53. Abuses
54. Questions
55. Aggravates
56. Praises
57. Acts sympathetically toward
58. Amazes
59. Communicates with
60. Exasperates
61. Gives orders to
62. Instructs
63. Betrays
64. Listens to
65. Is affectionate towards
66. Manipulates
67. Deceives
68. Reprimands
69. Associates with
70. Requests favors from
71. Bullies
72. Comforts
73. Erotically excites
74. Flirts with
75. Is aloof toward
76. Learns from
77. Influences
78. Seeks out
79. Supports
80. Acts superior to
81. Uses
82. Cheats

Table 5.3.1 A List of Interactions (cont.)

83. Helps
84. Flatters

Six male judges and six female judges, all college students, were asked to rate the descriptions of interactions between status-pair members on a nine-point scale. The written instructions, presented in Appendix F, were designed to make the bases for judgments as uniform as possible across judges and to suppress tendencies to shift to different, though related, bases (e.g., from "typical" to "expected").

5.3.2 Analysis and Results

Separate analyses were made for the male judges and the female judges. For each analysis the ratings of the six judges were averaged to obtain a final data matrix. The interactions were intercorrelated and the correlation matrix was factored by the Minimum Residual method and rotated to a Kaiser varimax criterion.

The results for male judges was a common factor space of fifteen dimensions. These results are shown in Table 5.3.2 A. The corresponding results for the female judges are shown in the right hand column in Table 5.3.2 A. The results for the two groups are in close agreement except that the analysis for males shows two minor factors (5 and 15) for which there are no corresponding factors in the analysis for the female judges.

The factors are quite readily interpretable. However, the number of variables loading heavily on one of the first three factors provides a reminder of the degree of selectivity involved in choosing 84 interactions. There is little doubt that the inclusion of additional interactions would have resulted in greater differentiation of interactions than is exhibited in the three major factors of the present analysis.

Since the technical aim of the study was the representation of relationships between the A-B individuals, each of the A-B pairs was assigned coordinates in the Interaction

Space. Table 5.3.2 B gives a list of the A-B pairs, together with their highest coordinates in the Interaction Space.

Part of the reason for the selection of the family as the object of the present study was that the phenomenon is sufficiently well known not to require an experimentally derived validity criterion comparable to the Means-Ends Case Study. The arrangement in Table 5.3.2 B makes it possible by inspection to construct a "thumbnail sketch" of the relationship between the members of an A-B pair, using the given coordinate values and the descriptions of the corresponding Interaction Space factors.

These results exhibit a good deal of face validity and no paradoxical characterizations. The accuracy of representation of our concept of the typical American family (with a middle class bias, of course, since the judges were college students) is shown not merely in the direct figures summarizing who does what to whom, but also in the relative balances of authority, cooperation, dependency, imitation, and criticizm among various family pairs, and in the fact that relationships among family members were generally more well-defined (higher numerical values) than those with or among non-family members.

5.3.3 Summary of the Part-Whole Study

The present study was directed toward a specific aspect of the part-whole problem, i.e., the representation of relationships among parts of a given whole. An effort was made to construct a geometric model for the typical relationships between members of a family. The results are internally consistent and show a good deal of face validity in the representation of these relationships.

The geometric form of representation here has the advantage that a great deal of

information can be "read off", or computed, without having to be entered and stored as separate facts. For example, the similarity of relationships between two A-B pairs can be computed by calculating the distance between the point locations of the two pairs in the Interaction Space. Similarity may be overall similarity or similarity in certain respects. With respect to a system such as described in Section 4, the following possibility is illustrative: Given, by "direct" report that A and B have the relation R, and that P and Q have the relation S, then if R is computed to be similar to S, and if A and B have the relation R by virtue of being parts of W, we may also compute the "hypothesis" that there is a corresponding whole, W^1 such that P and Q have the relation S by virtue of being parts of W^1.

Table 5.3.2 A Geometric Model for Interactions

Factor 1.	Is authoritative toward	
.928	Reprimands	.891
.927	Disciplines	.843
.863	Gives orders to	.888
.805	Is assertive with	.807
.770	Instructs	.746
.738	Frets about	.586
.692	Encourages	.486
.684	Impresses	.474
.621	Influences	.655
.614	Comforts	.406
.608	Is demanding of	.545
.595	Informs	.387
.587	Wakes up	.407
.567	Acts superior to	.860
.524	Acts lovingly towards	.373
.521	Praises	.332
.561	Is passive towards	.173
.344	Is more ambitious than	.790
.144	Is more competitive than	.771
.353	Is condescending to	.619
.304	Is patronizing to	.617
.292	Aspires to be like	.435
.152	Asks permission of	.375
Factor 2.	Is dependent on	
.908	Is accountable to	.846
.888	Asks permission of	.771
.879	Is dependent upon	.826
.856	Is protected by	.725
.777	Learns from	.526
.753	Protests to	.673
.744	Benefits from	.523
.735	Is indulged by	.578
.674	Aggravates	.444
.673	Rebels against	.538
.668	Burdens	.589
.666	Aspires to be like	.525
.654	Exasperates	.462
.645	Admires	.398
.645	Imitates	.555

Table 5.3.2 A Geometric Model for Interactions (cont.)

Factor 2.	Is dependent on (cont.)	
.614	Requests favors from	.339
.842	Is independent of	.833
.909	Is not restrained by	.831
.599	Is awed by	.588
.498	Eats with	.531
.507	Acts lovingly towards	.517
Factor 3.	Is friendly-cooperative with	
.891	Acts friendly with	.894
.876	Communicates with	.926
.876	Cooperates with	.889
.819	Agrees with	.908
.814	Assists	.886
.787	Listens to	.874
.786	Associates with	.891
.783	Helps	.867
.776	Works with	.850
.741	Acts sympathetically towards	.798
.702	Is courteous to	.736
.698	Informs	.833
.682	Influences	.663
.672	Praises	.820
.661	Supports	.778
.648	Flatters	.759
.6[illegible]0	Is patronizing to	.325
.624	Seeks out	.779
.616	Requests favors from	.817
.657	Abhors	.760
.677	Isolates himself from	.853
.680	Alienates	.516
.718	Avoids	.841
.802	Rejects	.837
Factor 4.	Cheats	
.887	Cheats	.864
.851	Deceives	.805
.818	Betrays	.559
.782	Abuses	.774
.710	Bullies	.856
.677	Lies to	.768

Table 5.3.2 A Geometric Model for Interactions (cont.)

Factor 4.	Cheats (cont.)	
.662	Uses	.750
.645	Attacks	.785
.539	Manipulates	.880
.345	Hides things from	.633
.396	Is courteous to	
Factor 5.	Conceals from	
.577	Hides things from	
.366	Lies to	
Factor 6.	Makes sexual advances to	
.919	Flirts with	.923
.890	Erotically excites	.918
Factor 7.	Exceeds in ambition and striving	
.782	Is more ambitious than	.387
.782	Is more competitive than	.408
Factor 8.	Annoys	
.533	Bothers	.558
.521	Aggravates	.593
.509	Exasperates	.643
.409	Burdens	.373
Factor 9.	Criticizes	
.786	Is critical of	.777
.641	Disagrees with	.542
.531	Abhors	.301
.480	Evaluates	.708
.441	Disavows	.240
.429	Hides things from	.083
	Frets about	.414
Factor 10.	Imitates	
.500	Imitates	.468
.438	Aspires to be like	.421
Factor 11.	Patronizes	
.523	Is condescending to	.543
.488	Is patronizing to	.532

Table 5.3.2 A   Geometric Model for Interactions (cont.)

Factor 12.	Is awed by	
.551	Is awed by	.430
	Amazes	.567
	Impresses	.319
Factor 13.	Shares domestic arrangements with	
.517	Eats with	.397
.438	Wakes up with	.506
.404	Acts lovingly towards	.319
.347	Is affectionate towards	.336
Factor 14.	Ignores	
.419	Ignores	.360
.336	Is aloof towards	.024
Factor 15.	Disavows	
.423	Disavows	

Table 5.3.2 B Interaction Pairs and Highest Coordinates *
in Interaction Space

01. A husband --- his wife
- 6.75 Makes sexual advances to
- 6.72 Shares domestic arrangements with
- 6.18 Is friendly-cooperative with

02. A father --- a policeman
- 4.04 Is friendly-cooperative with
- 3.67 Criticizes
- 3.25 Is dependent on

03. A father --- his younger daughter (about 7 years old)
- 6.72 Shares domestic arrangements with
- 6.00 Is autnoritative toward
- 4.79 Is friendly-cooperative with

04. A father --- his younger son (about 7 years old)
- 6.22 Shares domestic relations with
- 6.29 Is authoritative toward
- 5.46 Is friendly-cooperative with

05. A father --- his oldest daughter (about 17 years old)
- 5.58 Is authoritative toward
- 5.39 Shares domestic arrangements with
- 4.96 Is friendly-cooperative toward
- 4.83 Criticizes

06. A father -- his oldest son (about 17 years old)
- 5.29 Is authoritative toward
- 5.00 Shares domestic arrangements with
- 4.96 Is friendly-cooperative toward
- 4.58 Criticizes

07. A father --- a male criminal
- 5.67 Criticizes
- 4.00 Ignores
- 3.83 Disavows
- 3.83 Exceeds in ambition and striving

* To facilitate qualitative interpretation, figures shown are projections on estimation vector without correction for size of factor loadings of estimators.

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

08. A brother (about 7) --- his sister (about 7)
- 5.17 Shares domestic arrangements with
- 7.87 Is friendly-cooperative with
- 4.50 Criticizes
- 3.67 Conceals from

09. An older sister (about 17) --- her younger brother (about 7)
- 5.28 Shares domestic arrangements with
- 4.83 Criticizes
- 4.79 Is authoritative toward
- 4.67 Conceals from

10. An older brother (about 17) --- his younger brother (about 7)
- 5.37 Is authoritative toward
- 4.83 Shares domestic arrangements with
- 4.75 Criticizes
- 4.58 Exceeds in ambition and striving
- 4.50 Conceals from

11. A younger brother (about 7) ---- his older sister (about 17)
- 4.82 Shares domestic arrangements with
- 4.05 Annoys
- 3.91 Is friendly-cooperative toward

12. A sister (about 17) --- her brother (about same age)
- 5.12 Is friendly-cooperative with
- 4.75 Criticizes
- 4.61 Shares domestic arrangements with
- 4.33 Conceals from

13. A brother (about 17) --- his sister (about same age)
- 5.08 Is friendly-cooperative toward
- 4.41 Criticizes
- 4.39 Shares domestic arrangements with

14. A younger brother (about 7) --- his older brother (about 17)
- 5.33 Imitates
- 4.78 Shares domestic arrangements with
- 3.92 Is friendly-cooperative toward
- 3.78 Annoys

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

15. A wife --- her husband
- 7.16 Makes sexual advances to
- 6.72 Shares domestic arrangements with
- 5.79 Is friendly-cooperative with
- 5.62 Is dependent on

16. A policeman --- a father
- 3.88 Is friendly-cooperative with
- 3.29 Is authoritative toward
- 2.94 Annoys

17. A younger daughter (about 7) --- her father
- 7.04 Is dependent on
- 6.22 Shares domestic arrangements with
- 4.50 Is friendly-cooperative with
- 4.00 Is awed by

18. A younger son (about 7) --- his father
- 6.50 Is dependent on
- 6.00 Imitates
- 4.79 Is friendly-cooperative toward
- 4.67 Shares domestic arrangements with

19. An older daughter (about 17) --- her father
- 6.00 Is dependent on
- 5.28 Shares domestic arrangements with
- 5.12 Is friendly-cooperative with
- 3.67 Criticizes
- 3.16 Conceals from

20. An older son (about 17) --- his father
- 5.04 Is friendly-cooperative with
- 5.00 Shares domestic arrangements with
- 5.00 Is dependant on
- 4.50 Criticizes
- 4.33 Imitates

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

21. A male criminal --- a father
- 3.83 Conceals from
- 3.50 Criticizes
- 3.39 Annoys
- 3.33 Ignores

22. A mother --- her younger daughter (about 7)
- 7.00 Shares domestic arrangements with
- 6.38 Is authoritative toward
- 4.75 Criticizes
- 4.58 Is friendly-cooperative with

23. A younger daughter (about 7) --- her mother
- 6.91 Is dependent on
- 6.25 Imitates
- 5.94 Shares domestic arrangements with
- 4.83 Is friendly-cooperative toward

24. A mother --- her younger son (about 7)
- 6.50 Shares domestic arrangements with
- 6.00 Is authoritative toward
- 4.66 Is friendly-cooperative with
- 4.58 Criticizes

25. A younger son (about 7) --- his mother
- 6.79 Is dependent on
- 5.61 Shares domestic arrangements with
- 4.83 Is friendly-cooperative with
- 4.16 Conceals from

26. A mother --- her older daughter (about 17)
- 6.05 Shares domestic arrangements with
- 5.17 Is authoritative toward
- 4.91 Is friendly-cooperative toward
- 4.42 Criticizes

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

27. An older daughter (about 17) --- her mother

6.04	Is dependent on
5.44	Shares domestic arrangements with
5.04	Is friendly-cooperative with
4.58	Criticizes
3.83	Exceeds in ambition and striving
3.66	Conceals from

28. A mother --- her older son (about 17)

6.33	Shares domestic arrangements with
4.88	Is authoritative toward
4.87	Is friendly-cooperative with
4.50	Criticizes
4.00	Conceals from

29. An older daughter (about 17) --- a male criminal

4.92	Criticizes
4.17	Ignores
3.92	Exceeds in ambition and striving
2.75	Makes sexual advances to

30. A male criminal --- an older daughter (about 17)

3.33	Ignores
3.15	Makes sexual advances to
3.00	Annoys

31. An older brother (about 17) --- a male criminal

4.08	Criticizes
3.92	Exceeds in ambition and striving
3.00	Ignores

32. A male criminal --- an older brother (about 17)

3.50	Annoys
2.58	Criticizes
2.33	Conceals from

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

33. A male criminal --- another male criminal
    - 4.38 Is friendly-cooperative toward
    - 4.00 Conceals from
    - 3.83 Ignores
    - 3.55 Annoys

34. A brother (about 17) --- his brother (about same age)
    - 4.90 Is friendly-cooperative with
    - 4.67 Shares domestic arrangements with
    - 4.00 Criticizes
    - 3.83 Conceals from

35. A daughter (about 17) --- her sister (about same age)
    - 5.22 Shares domestic arrangements with
    - 5.21 Is friendly-cooperative with
    - 4.58 Criticizes
    - 3.25 Exceeds in ambition and striving

36. An older son (about 17) --- his mother
    - 4.75 Is friendly-cooperative toward
    - 4.60 Shares domestic arrangements with
    - 4.33 Criticizes
    - 3.96 Is dependent on
    - 3.83 Exceeds in ambition and striving

37. A younger sister (about 7) --- her sister (about same age)
    - 5.11 Shares domestic arrangements with
    - 4.71 Is friendly-cooperative with
    - 4.08 Criticizes
    - 3.33 Imitates

38. A sister (about 7) --- her brother (about same age)
    - 4.94 Shares domestic arrangements with
    - 4.25 Is friendly-cooperative with
    - 3.83 Conceals from
    - 3.83 Criticizes

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

39. A brother (about 7) --- his sister (about same age)
    4.33 Shares domestic arrangements with
    4.16 Is friendly-cooperative toward
    3.67 Conceals from
    3.58 Exceeds in ambition and striving
    3.58 Criticizes

40. A younger sister (about 7) --- her older sister (about 17)
    6.25 Imitates
    4.78 Shares domestic arrangements with
    4.00 Is friendly-cooperative toward
    3.56 Is dependent on
    3.50 Is awed by

41. An older sister (about 17) --- her younger sister (about 7)
    4.94 Shares domestic arrangements with
    4.54 Is authoritative toward
    4.29 Is friendly-cooperative with
    4.25 Criticizes
    4.08 Exceeds in ambition and striving
    4.00 Conceals from

42. A younger sister (about 7) --- her older brother (about 17)
    5.05 Shares domestic arrangements with
    4.38 Is friendly-cooperative with
    3.50 Is awed by
    3.25 Criticizes
    3.25 Imitates

43. An older brother (about 17) --- his younger sister (about 7)
    4.72 Shares domestic arrangements with
    4.61 Is authoritative toward
    4.58 Exceeds in ambition and striving
    4.17 Criticizes
    3.33 Ignores

44. A younger daughter (about 7) --- a male criminal
    2.75 Exceeds in ambition and striving
    2.67 Ignores

Table 5.3.2 B   Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

45. A male criminal --- a younger daughter (about 7)
   3.67 Ignores
   3.00 Exceeds in ambition and striving

46. A mother --- a male criminal
   4.33 Ignores
   3.91 Criticizes
   3.33 Conceals from
   2.83 Disavows

47. A male criminal --- a mother
   3.44 Annoys
   2.83 Criticizes
   2.75 Exceeds in ambition and striving

48. A younger brother (about 7) --- a male criminal
   3.50 Ignores
   2.89 Annoys
   2.25 Exceeds in ambition and striving

49. A male criminal --- a younger brother (about 7)
   4.33 Ignores
   2.66 Exceeds in ambition and striving
   2.50 Annoys

50. A male friend --- a younger son
   4.79 Is friendly-cooperative with
   3.50 Conceals from
   3.33 Criticizes

51. A younger son (about 7) --- a male friend
   4.92 Is friendly-cooperative with
   3.91 Imitates
   3.17 Criticizes

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

52. A male friend (about 17) --- an older daughter (about 17)
    5.62 Is friendly-cooperative with
    5.33 Makes sexual advances to
    3.25 Criticizes
    3.25 Exceeds in ambition and striving
    3.00 Conceals from
    3.00 Annoys

53. An older daughter (about 17) --- a male friend (about 17)
    6.08 Makes sexual advances to
    5.67 Is friendly-cooperative with
    4.08 Criticizes
    3.33 Conceals from

54. A younger daughter (about 7) --- a female friend (about 7)
    4.58 Imitates
    4.46 Is friendly-cooperative with
    3.75 Exceeds in ambition and striving
    3.08 Criticizes

55. A female friend --- a younger daughter (about 7)
    4.75 Is friendly-cooperative with
    3.83 Conceals from
    3.58 Criticizes
    3.58 Exceeds in ambition and striving

56. A daughter (about 7) --- her elementary school teacher
    6.00 Imitates
    4.88 Is dependent on
    4.88 Is friendly-cooperative
    4.33 Is awed by

57. A college professor --- a daughter (about 17) who is his student
    4.62 Is friendly-cooperative with
    4.25 Criticizes
    3.42 Exceeds in ambition and striving
    3.29 Is authoritative toward

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

58. A daughter (about 17) --- her college professor (male)
4.79 Is friendly-cooperative with
3.91 Criticizes
3.50 Conceals from
3.50 Makes sexual advances to

59. An elementary school teacher (female) --- a daughter (about 7) who is her student
5.75 Is authoritative toward
4.66 Is friendly-cooperative with
4.33 Criticizes
3.34 Exceeds in ambition and striving

60. An elementary school teacher (female) --- a college professor (male)
3.92 Is friendly-cooperative with
3.08 Criticizes
3.00 Is awed by
3.00 Makes sexual advances to

61. A college professor (male) --- an elementary school teacher (female)
4.42 Exceeds in ambition and striving
3.79 Is friendly-cooperative with
3.25 Criticizes

62. An adult male neighbor --- a father
4.79 Is friendly-cooperative with
3.00 Criticizes
2.77 Annoys
2.67 Conceals from

63. A father --- an adult male neighbor
4.88 Is friendly-cooperative with
3.33 Criticizes
3.17 Conceals from

64. An adult male neighbor --- a mother
4.38 Is friendly-cooperative with
3.41 Exceeds in ambition and striving
3.00 Conceals from
2.91 Criticizes

Table 5.3.2 8 Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

65. A mother --- an adult male neighbor
    4.21 Is friendly-cooperative with
    3.41 Criticizes
    3.17 Conceals from

66. An adult male neighbor --- an older son (about 17)
    4.04 Is friendly-cooperative with
    3.50 Criticizes
    3.50 Conceals from

67. An older son (about 17) --- an adult male neighbor
    4.12 Is friendly-cooperative
    3.67 Conceals from
    3.58 Exceeds in ambition and striving
    3.25 Criticizes

68. An adult female neighbor --- a father
    4.58 Is friendly-cooperative with
    3.00 Makes sexual advances to
    2.67 Criticizes

69. A father --- an adult female neighbor
    4.46 Is friendly-cooperative with
    3.67 Conceals from
    3.25 Criticizes
    2.92 Makes sexual advances to

70. An adult female neighbor --- a mother
    5.04 Is friendly-cooperative with
    3.33 Criticizes
    3.00 Conceals from
    3.00 Annoys

71. A mother --- an adult female neighbor
    5.00 Is friendly-cooperative with
    3.75 Criticizes
    3.17 Conceals from

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

72. An adult female neighbor --- an older daughter (about 17)
 4.21 Is friendly-cooperative with
 3.58 Criticizes

73. An older daughter (about 17) --- an adult female neighbor
 4.63 Is friendly-cooperative with
 4.00 Conceals from
 3.25 Criticizes
 3.25 Exceeds in ambition and striving
 3.08 Imitates

74. A plumber --- a father
 3.96 Is friendly-cooperative with
 3.06 Annoys

75. A father --- a plumber
 3.96 Is friendly-cooperative with
 3.75 Exceeds in ambition and striving
 3.28 Annoys

76. A plumber --- a mother
 3.92 Is friendly-cooperative with
 3.28 Annoys

77. A mother --- a plumber
 4.12 Is friendly-cooperative with
 3.44 Annoys
 2.83 Criticizes

78. A policeman --- another policeman
 5.58 Is friendly-cooperative with
 4.00 Criticizes
 3.37 Is authoritative toward
 3.21 Is dependent on
 3.00 Conceals from

Table 5.3.2 B Interaction Pairs and Highest Coordinates in Interaction Space (cont.)

79. A college professor (male) --- another college professor (male)
5.17 Is friendly-cooperative toward
4.00 Criticizes
3.67 Conceals from
3.00 Exceeds in ambition and striving

80. A plumber --- another plumber
4.71 Is friendly-cooperative
3.08 Exceeds in ambition and striving
3.00 Conceals from
3.00 Criticizes

81. A policeman --- an older son (about 17)
4.17 Criticizes
3.50 Is authoritative toward
3.44 Annoys

82. An older son (about 17) --- a policeman
4.00 Criticizes
3.50 Conceals from
3.28 Annoys
3.08 Exceeds in ambition and striving

83. A policeman --- a male criminal
4.92 Is authoritative toward
4.92 Criticizes
4.00 Exceeds in ambition and striving
3.67 Annoys

84. A male criminal --- a policeman
6.17 Conceals from
5.08 Criticizes
3.50 Annoys

6.0 Summary Discussion

Two empirical studies were reported, extending prior work in automatic linguistic data processing. Two previously developed procedures for indexing and retrieval of textual units were tested with "live" users in an operational setting. Both procedures, the Classification Space and the Attribute Space, showed a substantial degree of effectiveness in this setting. One method for the joint use of the two procedures was studied and found to provide a significant improvement over the use of either one by itself. The level of effectiveness of the sequential retrieval provided by the combined geometric models is shown in the fact that complete retrieval of 61 documents relevant to eleven requests could be accomplished with greater economy per document than a keyword procedure which retrieved only two-thirds of the relevant documents.

A brief critique of existing approaches to linguistic data processing was given. A new conceptual basis for research and development in this field was presented. By way of illustrating the potential of the new approach, a program of research and development centering around a hypothetical LDP system, the "State of Affairs Model", was presented.

The general nature of the State of Affairs Model and its derivation is indicated by the following:

1. The characterization of language as a form of behavior is more fundamental than the characterization of language as a system of signs, symbols, or signals.

2. The system of concepts adequate for the description of behavior has the maximum degree of logical power and complexity.

3. The only system of concepts adequate for the description of language is the system of behavior description.

4. An automatic linguistic data processing system must have the capacity for using behavior descriptive concepts as information formats. Thus, the technical problem for an LDP system is the computer implementation of the basic concepts of behavior description, particularly the concepts of "object", "process", "event", and "state of affairs".

5. An adequate LDP system cannot depend merely on rapid access to information explicitly represented in storage. Rather, it must have the computational power to generate information from information explicitly represented in storage. Because of this, the implementation of the basic concepts of behavior description cannot be accomplished piece-meal, though preliminary studies can be carried out separately for the various concepts. Rather, their effective implementation can be accomplished by a complex assembly (the State of Affairs Model) of subsystems each of which is itself substantially rich in computational (hence representational) power.

6. There is no reason to believe that any representation (description) of such a system which is both analytic and complete is possible, nor is it necessary.

7. One of the major technical strategies adopted for the implementation of basic behavior concepts as information formats is the pairing off of a geometric (or similar) model packed with simple

relationships and an analytic system for schematically representing precise, complex relationships.

8. The State of Affairs Model is in no sense a something for nothing proposition. Rather, it is designed to stand up under the possibility that language is every bit as complex as it seems to be. Hence, it requires a considerable amount of data gathering, data structuring, system design, parametric studies, and state of the art solutions throughout before production status in linguistic data processing is achieved. The SAM is designed to work precisely because so much has been put <u>into</u> the system.

9. In spite of its complexity, the SAM is a relatively simple prototype. Linguistic data processing appears to have reached a point where the most effective research and productive development must be carried out in the context of a functioning system and we may expect to find that to a substantial degree further research must be carried out by means of the system itself.

The two types of geometric model described above (Classification Space; Attribute Space) are incorporated into the design of the State of Affairs Model. The finding that the joint use of these two is an improvement over the use of either one alone, and the further finding that the joint use is substantially effective even by absolute standards, provide empirical backing for the expectation that an assembly of such subsystems which "is more than the sum of its parts" can be constructed.

Three exploratory studies were reported, dealing with the feasibility of particular technical approaches to the implementation of Means-Ends, Process-Activity, and Part-Whole concepts, each of which is included in the specification of a State of Affairs Model. The results of these studies are positive and encouraging, since they provide specific evidence to suggest that non-trivial state of the art solutions for these concepts can be achieved in an operational setting. Certainly, the difference between feasibility studies and substantive technical solutions must be kept in mind. However, as indicated above, it appears that further development of such solutions would be most effective in the context of a functioning system.

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Appendix A Instructions For Information Requests

Preparation Of Search Requests

Write 3 requests for information in the form of problem statements as described in the examples below. Two of the requests to be written can be oriented towards any problems which you are either trying to solve or about which you are generally concerned. The third request should be oriented towards a problem in which you are interested and which you feel there is a good probability that information concerning this problem can be found in our data base.

<u>Sample Requests</u>

1. How can one generate random numbers efficiently? Which pseudo-random sequences offer long periods and ease of generation?

2. What methods exist for calculating word associations based entirely upon the frequency of occurrence or co-occurrence of these words within a text unit?

3. I am beginning a research program of on-line retrieval experimentation. My view is that I'm only interested in experiments where indexing or retrieval has been experimented

Appendix A Instructions For Information Requests (Continued)

3. (Continued)

with using automatic techniques. Manual systems exhibit so much vocabulary control that I think they are detrimental to the use of a feed-back loop. Hence, I am interested in documentation discussing approaches to automatic indexing, preferably using full text as the index and searching it at the time of the search. Further, I'm interested in any research where feedback to a user is being used to help him modify a search and zero in on the desired information.

4. Can handsent Morse Code be transcribed automatically into English? What programs exist to read Morse Code?

5. I would like any information on Bayesian statistics. But in particular, I would like to know in what ways it differs from the classical Neyman-Pearson outlook on statistics. What are the advantages and disadvantages of each? How are the prior and posterior distributions calculated?

Appendix B User Requests

1. Request By User A

   What is known about the statistical distributions of words or concepts in English text?

   System words:

   994 Statistical distribution of words

   580 English text

2. Request By User A

   What impact does this knowledge (about the statistical distributions of words or concepts in English text) or lack of knowledge have on the application of standard statistical methods to information retrieval problems?

   System words:

   994 Statistical distribution of words

   580 English text

   1103 Statistical methods

   762 Information retrieval

3. <u>Request By User A</u>

Are non-parametric methods applicable to the statistical distribution of words or concepts in English text?

System words:

994	Statistical distribution of words
580	English text
897	Non-parametric methods

4. <u>Request By User A</u>

What documentation is available describing statistical-experimental design programming packages?

System words:

1103	Statistical principles
714	Experimental conditions
718	Programming packages

5. Request By User A

What documentation is available describing statistical-experimental design programming packages? Specifically, it would be preferred if such packages are available in Fortran? Factorial design programs or Latin-square design programs would be desirable, or mostly any design mentioned in Winer's "Principles of Statistical Experimental Design".

System words:

1103	Statistical principles
714	Experimental conditions
718	Programming packages
753	Fortran
737	Factorial designs
790	Latin square

6. Request By User B

I would like information regarding pre-processing for pattern recognition. (Pre-processing of the data occurs after measurements have been extracted from the environment, but before the data is presented to the decision maker. Its purpose is to operate on or transform the original data so as to decrease the computational load on the decision maker; i.e., prepare the data for the decision maker.) The papers written on pre-processing may be divided into two categories - dimensionality reduction, feature extraction, and miscellaneous.

System words:

960	Pre-processing measurements
739	Pattern recognition
127	Decisions
372	Dimensionality reduction

7. <u>Request By User B</u>

I would like information regarding pre-processing for pattern recognition. (Pre-processing of the data occurs after measurements have been extracted from the environment, but before the data is presented to the decision maker. Its purpose is to operate on or transform the original data so as to decrease the computational load on the decision maker; i.e., prepare the data for the decision maker.) The papers written on pre-processing may be divided into two categories - dimensionality reduction, feature extraction, and miscellaneous.

System words:

960 Pre-processing

739 Pattern recognition

127 Decisions

638 Feature extraction

8. Request By User B

I would like any information concerning learning systems. In particular, what are the possibilities of the application of automata theory to the synthesis of such systems.

System words:

572 Learning systems synthesis

28 Automata theory

9. Request By User B

What application, if any, of perceptive type devices as well as other classification theories have been made to the area of communication.

System words:

747 Perceptive type devices

271 Classification

295 Communicate

10. Request By User C

I am interested in techniques for data analysis. In particular, I wish information on "cluster-seeking techniques", as opposed to those of factor analysis and discriminant analysis. "Cluster-seeking techniques" may be defined as follows: Probabilistic techniques, signal detection, clustering techniques, clumping techniques, eigenvalue-type techniques, and minimal mode-seeking techniques.

System words:

157	Cluster analysis
613	Data analysis
1011	Probabilistic inference
804	Signal detection
351	Clumping techniques
464	Eigenvalue-type techniques
657	Minimal mode-seeking techniques

11. Request By User C

I would like any information concerning Bayesian statistics. In particular, I would like to know if one can define or devise multiple decision procedures from the Bayes approach.

System words:

232 Bayesian statistics

886 Multiple decision procedures

12. Request By User C

How sensitive are Bayes procedures to the prior distribution?

System words:

232 Bayesian statistics

991 Prior distribution

13. Request By User C

Finally, I would like a comparison of the Bayes approach to other classical decision theoretic approaches.

System words:

232 Bayesian statistics

487 Decision theory

14. <u>Request By User D</u>

I am beginning a research program of on-line retrieval experimentation. My view is that I'm only interested in experiments where indexing or retrieval has been experimented with using automatic techniques. Manual systems exhibit so much vocabulary control that I think they are detrimental to the use of a feedback loop.

System words:

859	On-line retrieval
729	Experimental results
478	Index
944	Retrieval
104	Automatic indexing

15. Request By User D

I am interested in documentation discussing approaches to automatic indexing, preferably using full text as the index and searching it at the time of the search. Further, I'm interested in any research where feedback to a user is being used to help him modify a search and zero in on the desired information.

System words:

104	Automatic indexing
666	Text
478	Index
334	Feedback

16. Request By User D

I am involved in an automatic extracting program. One problem we are having is that the sentences chosen by the computer are sometimes not too meaningful due to lack of context I would like to find a syntactic/semantic means for choosing other sentences which are inherently related to the ones chosen by our extracting algorithm. A good example of what I'm after is a program for coping with referments such as "it". By knowing what "it" refers to, I may deduce what sentence is structurally linked to the sentence containing the referrent "it".

System words:

80	Automatic extracting
596	Sentences
1034	Syntactic
979	Semantics
3	Algorithm

17. Request By User E

How many levels of computer programming languages exist? Give a description of each and names of some of the languages available in each category.

System words:

709	Programming language
255	Categorizer

18. Request By User F

I am sponsoring a project directed at developing an evaluation tool for machine translation. Since machine translation is a process of communication, I am interested in research which is involved in measuring the effectiveness of any communication process in some quantitative manner. I am also interested in any other approaches to the problem of machine translation evaluation.

System words:

322	Language translation
295	Communicate
151	Efficiency
141	Evaluation

Appendix C Equivalent User Requests

Request	Request
A	1,2,3
B	4,5
C	6,7
D	8,9
E	10
F	11,12,13
G	14
H	15
I	16
J	17
K	18

Appendix D Retrieval Studies Documents

1. Some Minimax and Bayes Procedures for Selecting One of Two Medical Treatments.
2. Some Two-Step Sampling Procedures.
3. Some Optimal Properties of Ranking Procedures With Applications in Multivariate Analysis.
4. Sequential Search Problems.
5. Duality in Mathematical Programming.
6. Generalized Decomposition of Incomplete Finite Automata.
7. A Systems Approach to Strategy Formulation When Decisions Must Be Made Under Conditions of Uncertainty.
8. Power of the Likelihood-Ratio Test of the General Linear Hypothesis In Multivariate Analysis.
9. Some Nonparametric Bayesian Estimation Problems, With Part XX Monotonicity of Rank Order Likelihood Ratios.
10. Relatedness and Semantic Generalization.
11. Information Processing in the Acquisition and Recall of Structured and Unstructured Strings of Verbal Items.
12. A Resource Allocation Model for Research and Development Management.
13. On Threshold Logic.

14. An Adaptive Pattern Recognition Machine Using Neuron-Like Elements. K. Fu.
15. Computer Characterization of XX-Port Networks.
16. The Automatic Assignment and Sequencing of Computations On Parallel Processor Systems Volume I, Program Listings Volume II. D. F. Martin.
17. Estimation of Variance Components in Incomplete Block Designs.
18. An Introduction To Graph Theory. E. L. Bruyr.
19. Extensions of the Two-Armed Bandit and Related Processes With On-Line Experimentation. K. H. Quisel.
20. Development and Evaluation of a Matrix Transformation Useful in Personnel Classification. R. C. Sorenson.
21. A Stimulus Conditioning Learning Model and Its Application to Pattern Recognition. W. H. Brockman.
22. A Study of Pattern Recognition Systems With A Sequential Learning Procedure. C. Chen.
23. The Optimal Control of Queues With Application To Computer Systems. D. W. Fife.
24. Laryngeal Frequency Analysis For Linguistic Research. N. P. McKinney.

Appendix D Retrieval Studies Documents (Continued)

25. An Application of Stochastic Automata to the Synthesis of Learning Systems. R. W. McLaren.

26. Learning Probability Spaces for Classification and Recognition of Patterns With or Without Supervision. E. A. Patrick.

27. An Adaptive Pattern Classification System. J. D. Patterson.

28. Estimation of Probability Density and Distribution Functions. J. A. Tabaczynski.

29. Applications of Bayesian Statistics To Actuarial Graduation. G. S. Kimeldorf.

30. Application of the Theory of Generalized Matrix Inversion to Statistics. T. O. Lewis.

31. Equivalences Between Probabilistic Sequential Machines. C. V. Page.

32. The Simultaneous Measurement of Utilities and Subjective Probabilities. H. R. Lindman.

33. An Information-Processing Model of Certain Aspects of Paired-Associate Learning. W. H. Wynn.

34. Iterative Design Procedures in Pattern Classification. L. Barbosa.

Appendix D Retrieval Studies Documents (Continued)

35. An Information Processing Model of Human Concept Learning. W. B. Denton.

36. Testing Hypotheses With Categorical Data Subject to Misclassification. K. Assakul.

37. On the Structure and Automorphisms of Finite Automata. Z. Bavel.

38. A Secondary Bayes Approach to the Two-Means Problem. M. B. Brown.

39. Partially Ordered Classes of Finite Automata. J. Nievergelt.

40. Decomposition and Interconnected Systems in Mathematical Programming. Paul Rech.

41. The Problem of Data in Fact and Value Contexts. Foster Eliott Tait.

42. An Examination of Human Strategies for Acquiring Information. Daniel Jay Davis.

43. Syntactic Structures and Judgements of Auditory Events, A Study of the Perception of Extraneous Noise in Sentences. Merrill Fredrick Garrett.

44. Discriminant Functions Properties Classes and Computional Techniques. David West Peterson.

Appendix D Retrieval Studies Documents (Continued)

45. Errors in Finite Automata. Philip Simon Dauber.

46. Bayesian Statistical Inference for Multivariate Location Parameters. James Mills Dickey.

47. Comparison of Two Drugs by Multiple State Sampling Using Bayesian Decision Theory. Armand Verne Smith, Jr.

48. Empirical Bayes and Subminimax Approach to Sequential Decision Problems and Applications. Melvin Tainiter.

49. Drinking Motivation, A Cluster Analytic Study of Three Samples. Peter Holmes Grossman.

50. Classification of Sets of Stimuli With Different Stimulus Characteristics and Numerical Properties. Shiro Imai.

51. Measurement Selection for Linear Discriminents Used in Pattern Classification. S. E. Estes.

52. Minimum-Cost Design of Defect-Tolerant Digital Magnetic Memories. J. S. Eggenberger.

53. Statistical Extrapolation in Certain Adaptive Pattern-Recognition Systems. F. H. Glanz.

54. Investigation and Simulation of a Self-Repairing Digital Computer. I. Terris.

55. Frequency Dictionary of Chinese Words. E. S. Liu.

Appendix D Retrieval Studies Documents (Continued)

56. <u>Nonparametric Classification and Nonparametric Density Function Estimation</u>. D. O. Loftsgaarden.

57. <u>A Developmental Study of the Semantic Differential</u>. R. S. Lilly.

58. <u>An Experimental Investigation of a Mathematical Learning Model</u>. P. J. Best.

59. <u>The Generalization Function in the Probability Learning Experiment</u>. M. V. Levine.

60. <u>The Problem of Classifying Members of a Population Into Groups</u>. R. E. Flora.

61. <u>Some Parametric Empirical Bayes Techniques</u>. J.R. Rutherford.

62. <u>Markov Chains and Probability Learning</u>. N. J. Castellan, Jr.

63. <u>An Investigation of a Multiple Iteration Rate Incremental Data Processor</u>. R. A. Bruce.

64. <u>Design of Thin Film Parametron Digital Computer Circuits</u>. H. S. Gold.

65. <u>A Linguistic Study of the Formation of Chinese Characters</u>. B. K. Rankin III.

66. <u>Sequential Decision Rules for a Multiple Choice Problem</u>. D. R. Barr.

Appendix D Retrieval Studies Documents (Continued)

67. Inductive Inference on Computer Generated Patterns. M. K. Keller.

68. Word-Frequency as a Psychological Variable. H. E. Tryk.

69. A Higher-Level Machine-Orienter Language as an Alternative to Assembly Language. B. V. Schorre.

70. A Graphic Notation for Describing Multicomputer Nets Some Preliminary Notions. C. J. Shaw.

71. Interactive Displays for Document Retrieval. H. Borko and H. P. Burnaugh.

72. Guidelines For The Utilization of Statisticians in the Design and Execution of Information Retrieval System Evaluation Studies. A. A. Anderson.

73. Computational Studies of Presentation Strategies for a Multilevel Model of Learning. W. Karush and R. E. Dear.

74. Breaking the Cost Barrier in Automatic Classification. L. B. Doyle.

75. Matrix Manipulations by Computer Computation of Functions of a Matrix. J. Staudhammer.

76. Owl Reference Guide. R. E. Long.

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81. Dynamic Program Behavior Under Paging. G. Fine, C. Jackson, P. McIsaac.

82. Multi-Level File Structure As A Frame of Reference for Measuring User Interest. A. A. Anderson.

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86. User Interaction With the Trace System. R. J. Meeker.

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88. An Exploratory Investigation of Programmer Performance Under On-Line and Off-Line Conditions. E. E. Grant and H. Sackman.

Appendix D Retrieval Studies Documents (Continued)

89. More on Understanding Understanding Utterances. P. Ziff.

90. A Feasibility Study for Automated Fingerprinted Identification. C. A. Cuadra.

91. Epic Users Manual. N. E. Cole.

92. The Gist of GI's Generalized Information System. C. J. Shaw.

93. Operational Management of Time-Sharing Systems. R. R. Linde, P. E. Chaney.

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96. Handwriting and Pattern Recognition. M. Eden.

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98. Eulogismographic Nonlinear Optical Image Processing for Pattern Recognition. J. K. Hawkins and C. J. Munsey.

99. On the Effectiveness of Receptors in Recognition Systems.

100. An Approach to Automatic Photographic Interpretation. Dr. Azriel Rosenfield.

101. <u>Some Experiments in Spoken Word Recognition</u>. J. H. King, Jr. and C. J. Tunis.

102. <u>A Technique for Determining and Coding Subclasses in Pattern Recognition Problems</u>. R. L. Mattson and J. E. Dammann.

103. <u>Experiments on the Mechanization of Game-Learning, Part One Characterization of the Model and Its Parameters</u>. Donald Michie.

104. <u>Intelligent Machines and Hazy Questions</u>. Richard K. Overton.

105. <u>Test of a Statistical Explanation of the Rank-Frequency Relation for Words in Written English</u>. George A. Miller, Edwin B. Newman, Harvard University.

106. <u>Long-Range Constraints in the Statistical Structure of Printed English</u>. N. G. Burton and J.C.R. Licklider.

107. <u>Final Note on a Class of Skew Distribution Functions Analysis and Critique of a Model Due to H. A. Simon</u>. Benoit Mandelbrot.

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119. An Analysis of Time-Sharing Computer Systems Using Markov Models. J. L. Smith.

Appendix D Retrieval Studies Documents (Continued)

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F. J. Corbato, V.A.V. Yssotsky.

121. System Design of a Computer for Time-Sharing Applications.

E. L. Glaser, J. F. Couleur, and G. A. Oliver.

122. Structure of the Multics Supervisor. V. A. Vyssotsky,

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123. The Structure of On-Line Information Processing Systems.

J. B. Dennis and E. L. Glaser.

124. Program and Addressing Structure in a Time-Sharing Environment. M. B. Arden, B. A. Galler, T. C. Obrien and F. H. Westervelt.

125. Segmentation and the Design of Multiprogrammed Computer Systems. J. B. Dennis.

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127. A Programmers Utility Filing System. M. V. Wilkes.

128. A General-Purpose File System for Secondary Storage.

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D. R. Fitzwater.

130. The Organization of Structured Files. B. J. Dzubak and C. R. Warburton.

131. New Demands on Software. Dr. Thomas E. Kurc.

132. The Evolving Time-Sharing System at Darthmouth College. Kenneth M. Lochner.

133. The Evolution of Real-Time Executive Routines. Hal B. Becker.

134. Supervisory Systems for the Darthmouth Time-Sharing System. Thomas E. Kurtz and Kenneth M. Lochner, Jr.

135. A Design for a Multiple User Multiprocessing System. James D. McCullough, H. Kermith, H. Speierman and Frank W. Zurcher.

136. Automatic Subclass Determination for Pattern-Recognition Application. O. Firschein and M. Fischler.

137. Learning Matrices and Their Applications. K. Steinbuch and U. A. Piske.

138. Adaptive Systems in Pattern Recognition. H. Kazmierczak and K. Steinbuch.

139. The Classification of a Set of Elements With Respect to a Set of Properties. P. Constantinescu.

140. <u>On Some Clustering Techniques</u>. R. E. Bonner.

141. <u>Nonsupervised Adaptive Signal Detection and Pattern Recognition</u>. D. B. Cooper and P. W. Cooper.

142. <u>Subjective Probabilities Inferred From Decisions</u>. W. Edwards.

143. <u>The Theory of Decision Making</u>. W. Edwards.

144. <u>Bayesian Statistical Inference For Psychological Research</u>. W. Edwards, H. Lindman and L. J. Savage.

145. <u>Dynamic Decision Theory and Probabilistic Information Processing the Development of a Dynamic Decision Theory</u>.

146. <u>Sensitivity of Subjective Probability Revision</u>. C. R. Peterson and A. J. Miller.

147. <u>Probabilistic Information Processing System for Diagnosis and Action Selection</u>. W. Edwards.

148. <u>Conservation in Complex Probabilistic Inference</u>. L. D. Phillips, W. L. Hays and W. Edwards.

149. <u>Revision of Continuous Subjective Probability Distributions</u>. C. R. Peterson and L. D. Phillips.

150. <u>Value As a Determiner of Subjective Probability</u>. P. Slovic.

151. <u>Accuracy and Consistency in the Revision of Subjective Probabilities</u>. L. R. Beach.

Appendix D Retrieval Studies Documents (Continued)

152. Research on a Simulated Bayesian Information-Processing System. D. A. Schum, I. L. Goldstein and J. F. Southard.

153. Studies in Probabilistic Information Processing. R. J. Kaplan and Newman.

154. The Recognition of Handwritten Numerals Analysis.

155. Machine Recognition of Hand Printing. R. J. Spinrad.

156. Character Recognition by Line Tracing.

157. Recent Work on Systems to Facilitate the Input of Graphical Information to a Computer Has Resulted in the Development of the Light Pen and the Tablet.

158. Computer Recognition of On-Line Hand-Written Characters. M. I. Bernstein.

159. Real Time Recognition of Hand-Drawn Characters. Warren Teitelman.

160. A System for Automatic Recognition of Handwritten Words. Paul Mermelstein and Murray Eyden.

161. Experimental Studies of Handwriting Signals.

162. Electronic Retina.

163. Nonlinear Servoanalysis of Human Lens Accommodation. L. Stark, Y. Takahashe and G. Zames.

164. Interactive Displays for Document Retrieval. H. Borko and H. P. Burnaugh.

165. Information Search Optimization and Iterative Retrieval Techniques. J. Rocchio and G. Salton.

166. Revelance Feedback in Information Retrieval. J. J. Rocchio.

167. Information Dissemination and Automatic Information Systems. Gerard Salton.

168. Computer Based Concept Searching of United States Patent Claims. A. J. Riddles.

169. The IBM Technical Information Retrieval Center Itric System Techniques and Applications. Samuel Kaufman.

170. Syntran a Text Information Organization and Retrieval System. Lamar Lbriner.

171. An Information System With the Ability to Extract Intelligence From Data. T. L. Wang.

172. Evaluation of Machine-Produced Abstracts.

173. An Experiment in Evaluating the Quality of Translations. J. B. Carroll.

174. A Reading Comprehension Test.

175. Some Psychological Methods for Evaluating the Quality of Translations. G. A. Miller and J. G. Beebe-Center.

Appendix D Retrieval Studies Documents (Continued)

176. Polynomial Approximately a New Computational Technique in Dynamic Programming. R. Bellman, R. Kalaba and B. Kotkin.

177. Slave Memories and Dynamic Storage Allocation. M.V. Wilkes.

178. Queueting in a Memory-Shared Computer. D. Fife and R. Rosenberg.

179. A General Purpose Programming System for Random Access Memories. C. W. Bachman and S. B. Williams.

180. Derivation of a Waiting-Time Factor for a Multiple-Bank Memory. Ivan Flores.

181. The Rope Memory a Permanent Storage Device. F. Kuttner.

182. A Large Capacity Cryoelectric Memory With Cavity Sensing. L. Burns, D. Christiansen and R. Gange.

183. A Search Memory Subsystem For a General-Purpose Computer. Albert Kaplan.

184. Investigation of a Woven Screen Memory System. J. S. Davis and P. E. Wells.

185. Memories in Present and Future Generations of Computers. Jan A. Rajchman.

186. Memory Devices for Modern Computer Memories. Andrew C. Knowles.

Appendix D Retrieval Studies Documents (Continued)

187. Statistical Programs at the University of North Carolina. Norman Bush.

188. Fixed Associative Memory Using Evaporated Organic Diode Arrays. M. H. Lewin, H. R. Beelitz and J. A. Richman.

Appendix E Distances In C-Space and A-Space

Classification Space

Request	Closest Relevant Document	Furthest Relevant Document	Mean Distance	Number of Relevant Documents
A	1.35	3.96	2.49	9
B	1.91	2.72	2.23	4
C	1.03	2.95	1.82	4
D	2.63	4.32	3.33	5
E	1.14	2.74	1.91	7
F	1.02	3.23	2.20	16
G	1.99	2.28	2.12	6
H	1.57	2.54	2.02	4
I	1.56	1.56	1.56	1
J	2.00	2.24	2.12	2
K	1.44	2.63	2.00	4

Appendix E Distances in C-Space and A-Space (Continued)

Attribute Space

Request	Closest Relevant Document	Furthest Relevant Document	Mean Distance	Number of Relevant Documents
A	1.72	3.96	2.80	9
B	1.94	2.51	2.30	4
C	3.08	3.79	3.36	4
D	3.41	5.12	4.10	5
E	2.40	3.76	2.98	7
F	1.82	5.26	2.94	16
G	2.10	3.76	3.17	6
H	2.21	2.91	2.60	4
I	2.92	2.92	2.92	1
J	3.52	3.82	3.67	2
K	2.84	3.60	3.05	4

Appendix F.
Instructions for Part-Whole Psychometric Study

Study of Family Structure
Orientation

The purpose of this study is to obtain quantitative measures of the similarities and differences among various family members such as "mother", "father", "son", and "daughter". This is accomplished by having people make judgments about a set of sample items each of which describes an action or relationship involving two family members (and occasionally, a non-family member). An example of a sample item would be "A husband argues with his wife".

Your basic task in rating each item is to decide the degree to which the action or relationship is typical for the two family members.

Your decision for each item is expressed by making a check mark on the numerical scale which accompanies each sample item. The use of the scale is explained below.

Rate each item independently. Do not look back and forth in the booklet or try to remember how you rated other items. Do the items rapidly and in order, without skipping any.

The Scales:

You will be using scales like this one:

0	1	2	3	4	5	6	7	8

In general, the more nearly typical the sample item is, the higher the number of the scale position you should mark. Use the following as a guide to the use of specific scale positions.

The sample item is not at all typical. The state or action almost never occurs between persons in the statuses named and would call for a special explanation if it did.

mark | 0 |

The sample item is far from typical, but it sometimes occurs. Ordinarily you would not expect it. Under these conditions:

If less typical, mark | 1 |

If more typical, mark | 2 |

The sample item is not really typical, but it would not be surprising if it occurred. Under these conditions:

If less typical, mark | 3 |

If more typical, mark | 4 |

The sample item is quite typical. It describes an action or relationship which often occurs and is to be expected. Under these conditions:

If less typical, mark | 5 |

If more typical, mark | 6 |

The sample item is highly typical. It usually occurs and it would be surprising and would call for a special explanation if it did not occur. Under these conditions:

If less typical, mark | 7 |

If more typical, mark | 8 |

APPENDIX P

Linguistic Research Institute Report No. 7

Rule-Following in Grammar and Behavior

by

Peter G. Ossorio

In recent years transformational linguists have with increasing articulateness and effectiveness expressed concern over the apparent inadequacy of learning theory in accounting for the acquisition and exercise of the syntactic structures which are believed to mediate verbal behavior. For example, a recent exchange between Braine (1965) and Bever, et al (1965a, b) is concluded with the following admonition from the linguists: "As the empirical basis for assuming an abstract underlying structure in language becomes broader and the explanatory power of that assumption becomes deeper, we recommend to all psychologists that they seriously question the adequacy of any theory of learning that cannot account for the fact that such structures are acquired" (Bever, Fodor, and Weksel, 1965b).

The present paper will not deal with specific contentions about alternative grammatical formulations or alternative associationistic representations of grammatically structured behavior. The purpose is, rather, to extend the scope of the dialogue in such a way as to remove the basis for contention. Briefly, I shall try to show that although the specific criticism directed toward associationist learning theory appears to be justified at the present time, the demand that psychological theory should provide the mechanisms for acquiring and exercising linguistic competence is a move which violates the methodological character of transformational theory itself. I shall try, by indicating an alternative formulation of psychological theory, to show that that move is also an unnecessary one.

The alternative formulation (Ossorio, 1966a) is one which is likely to be unfamiliar to the reader. The theory has important continuities with the recent "Ordinary Language", or "Oxford", tradition in philosophy. However, it goes significantly beyond previous formulations in scope and systematization, and is psychological rather than philosophical. It may be characterized as a systematization of what has previously been informally identified as the "rule-following model" of human behavior (e.g., by Mischel, 1964).

Four points need to be made about the theory by way of summary and introduction: (1) It is fundamentally different. In terms of Morris' classic (1938) distinction of syntactic, semantic, and pragmatic, the rule-following model is a pragmatic theory[2] having the reflexive character of natural language, whereas the commonly known behavior theories in psychology are semantic theories and are subject to the linguistic stratification characteristic of artificial languages. (2) It is the methodological counterpart, in Psychology, of transformational theory in Structural Linguistics. (3) Substantively, it is a "theory of performance", in the linguists' sense, but because two key concepts within the system are "competence" concepts, any systematic description of a particular sort of competence, including transformational or other descriptions of linguistic competence, can be assimilated in toto. (4) The relation of the two "competence" concepts to the system as a whole and to each other guarantees that the conclusion that an English

speaker does not, in general, know how to use the grammatical structures of English is non-paradoxical and has no pernicious consequences for either the behavioral account or the grammatical one. But then also, there is no problem of explaining how the speaker learned to use those grammatical structures. The two distinct competence concepts neatly separate the loci of relevance of grammatical theories and learning theories within psychological theory.

The Rule-Following Model

Ordinarily, the task of presenting a psychological theory in a limited space is the task of summarizing what the theory says. This is because we seldom see any problem in how to use the theory, since our psychological theories, following the familiar pattern of semantic theory, are presented as putatively true descriptions of the world, and we have standard ways of using something of that sort, so that the specific use of the theory follows readily from its content. In fundamental contrast, the rule-following model is primarily a formulation of use, and it is the content which "follows" from the use. It literally does not, and could not "say" anything at all, since it is a single, complex concept[3] and not a set of propositions.

The single concept in question is the concept of a person. ("Rule-following model", "concept of a person", and "Person concept" are used interchangeably.) Curiously enough, and also of vital

importance, the use of that concept provides the primary exemplar of that concept (i.e., the concept codifies its own use), so that someone who understood the use of that concept would also understand the concept itself. The indicated form of presentation of the concept is, therefore, training in the use of the concept as formulated, and that has indeed proved to be by all odds the most effective. Clearly, some bootstrapping is called for if it is to be presented in an expository fashion.

We may hope to accomplish that bootstrapping in the following way: First, the concept of <u>intentional</u> <u>action</u> is introduced, intentional action being both the basic unit of behavior and the "universal law" of behavior. The use of concepts (any concept, including that of intentional action) is shown to be an aspect (a parameter) of intentional action. Second, the concept of intentional action is shown to be a logical component of a more complex concept, i.e., the concept of a person. Finally, the circle is closed by saying that the use of a certain concept, i.e., the concept of a person, is a case of intentional action and is what qualifies an individual as a person. If an individual has the competence to use the concept of a person, then <u>necessarily</u>, he is a person.

Thus, the rule-following model is both a "theory of competence" and a "theory of performance", in spite of the fact that in linguistics these are generally considered to be sharply differentiated, if not mutually exclusive.[4]

In this section, the two basic concepts, or paradigms (intentional action; individual person) will be presented, with major emphasis on the first. The two concepts constitute the "content" of the rule-following model, and presenting them is as close as one can come to summarizing "what the theory says". In the primary formulation presented in "Persons" (Ossorio, 1966a), the two paradigms are embedded in an extensive methodological complex. In that presentation, several hundred pages of argument, analysis, illustration, and comparison are given, all of which amount to implicit training in the use of the two paradigms. That cannot be abstracted and summarized. What is given below, in addition to the two paradigms, is a set of comments on the features of the model which are most relevant to the present discussion. The comments are designed to provide a guide to the use of the Person concept and to head off the most likely errors in its use, but of course, they cannot deal with every type of question that might arise.

Paradigm of Intentional Action (PIA)

The first paradigm, that of intentional action, is commonly presented as a diagram consisting of a diamond with the corners labelled successively "Know", "Want", "Know How", and "Performance".[5] This is a useful visual aid for representing logical symmetry and acausality. The point of the diagram is that _in any intentional action a person necessarily (a) is trying to achieve something he_

wants, (b) has the relevant knowledge for making the attempt, (c) is recognizably doing the sort of thing one would do in order to achieve that, and (d) his doing that is neither accident nor coincidence, luck, chance, etc., but the exercise of acquired skills. That is the paradigm of intentional action.

Comments on PIA

(1) The primary use of PIA is in accordance with the following maxims. M1: "If a person has a reason[6] to do X, he will do it--unless he has a stronger reason to do something else" (a principle of "response selection" in motivational terms). M2: "If a person recognizes an opportunity to get something he wants, he has a reason to try to get it" (a principle of response selection in cognitive terms). M3: "If a situation calls for a person to do something which he does not know how to do, he will do something he does know how to do" (a prinicple of response selection in terms of competence). We use these maxims, together with PIA, to arrive at an understanding of what we observe.

(2) There are obvious parallels between PIA and other general behavior theories. There is substantial evidence to support the claim ("Persons", Parts IV and V) that every viable psychological theory of behavior (e.g., S-R, Expectancy, psychoanalytic, Self, and Field theories) has at its core some paraphrase of both PIA and M1 and that its use conforms to M2 and M3 as well (see also comment #9). There are decisive reasons for avoiding technical

psychological terminology in PIA, a most important one being that since such technical terms have only an invented use they cannot in fact be effectively used in the reflexive, pragmatic way, but are restricted to a "simple descriptive," semantic use (see 6, below). The asymmetry is illustrated by the following: Given PIA, one fairly readily identifies the paraphrases in the several theories; in contrast, it is so far from evident that any portion of one such theory is legitimately characterized as a paraphrase of some portion of another such theory that they are regarded as simply incommensurable in a standard textbook in personality theory (Hall and Lindzey, 1957). Nor is there any question of which is a paraphrase of which, for the ordinary language terminology of PIA antedates any psychological theory by a very respectable margin. The systematization provided by the rule-following model gives to much of ordinary language a methodological status heretofore thought to be restricted to technical terminology, particularly "theoretical constructs."

(3) What is represented by PIA is that the basic unit of behavior (intentional action) has those four parameters. The latter are to be distinguished from either constituents or causes. The four parameters are not four classes of objects, events, or processes which, when suitably combined, bring about a different event or process called "behavior." Neither do "want," "know," and "know how" identify three types of event, process, or condition which cause the fourth ("performance") to happen,[7] nor do they designate anything

occult, hypothetical, or physiological. Rather, what we observe by way of behavior is always[8] intentional action, and the four parameters codify the fundamental kinds of distinction we make between one action and another. If that seems strange or forced, that will be because it contrasts with the causal-process model which we commonly take for granted in our technical behavior descriptions. We can easily find appropriate familiar analogues. For example, "brightness," "hue," and "saturation" have an analogous relationship to "color." That is, they codify basic ways we have (actually have, not merely logical possibilities) of distinguishing between different colors, and they are not, e.g., parts of colors, separate items which when brought together form a color, or prior things which cause colors. What we observe are colors. And what we observe are intentional actions.

(4) If the color analogy suggests that we have reverted to "mere taxonomy," "Aristotelian thinking," or something equally pernicious, it would be well to remember that intentional action per se is an observable behavioral process which is so out and out dynamic that even when a person is standing stock still with his eyes closed it will make sense to ask and answer the question, "What is he doing now?" In the rule-following model, "active organism" is not a daring theoretical postulate, but brute fact simply acknowledged.

(5) "Intentional action" designates a concept, not a statement or proposition, and so it is "non-empirical" not in the sense of legislating facts as opposed to discover them, but because it

no more could be either true or false than a table could. Concepts are pre-empirical, not anti-empirical.

(6) Ascriptions of particular intentional actions to some individual, P, are the way we formulate our understanding of P's behavior. That is common to both social scientists and non-scientists. But the strategic point of technical psychological application of the concept is not in a simple, direct description of P, which we then try to verify (that is the common psychological approach, the "semantic model"). Rather, it comes in our seeing intentional action as the concept which P necessarily uses in his observations of other persons, and in his understanding of them and behavior toward them, and toward himself as well.[9] But P's use of that concept (see below on "using concepts") is itself a case of intentional action, since the use of concepts of whatever kind is what is codified by the "know" parameter of intentional action. Thus, "intentional action" does, after all, describe P's behavior, but now in a reflexive sense which goes far beyond simple description. PIA now operates not as a falsifiable description of what goes on, but as a rule for constructing descriptions and as a standard for what qualifies as a possible description. What is empirical is which action it is that takes place, and for answers of that sort, we depend on our observational skills, and, occasionally, on inference. PIA is not a hypothesis, but rather, a "mechanism", a computational device for making the transition from observation to action.[10] Clearly, this feature has many significant methodological ramifications only three of which will be mentioned here:

(6a) The rule-following model is a so-called "rational" model of man. Psychological theorists have long given wide berth to "rationalistic" conceptualizations of human behavior for the very good reason that there is a significant contrast to be drawn between meeting our standards of achievement or reasonableness, on the one hand, and "what actually happens," on the other. This is one of the primary bases for Miller's (1965) claim that psychology ought to provide "performance models" embodying mechanisms which will account not merely for verbal behavior which measures up to the linguists' standards of correctness, but also for slips, errors, omissions, etc.--that is, "what actually happens" when a person speaks. This is the "theory of performance" vs "theory of competence" distinction again. It is important, therefore, to point out that because of the reflexive character of the concept of intentional action and its pragmatic and "computational" character, PIA permits us to characterize the "irrational" instances and aspects of human behavior with unparalleled cogency. This is so because the systematization provides a characterization of the irrationality itself, since both the relevant standards and "what actually happens" are <u>within</u> the scope of the rule-following model. In contrast, our psychological conceptual systems have heretofore provided no more than a rationale for the <u>occurrence</u> of irrationality to a theorist who was required to have a specification of <u>what</u> it was that occurred already given in extra-theoretical terms (because causal-process models can deal with events and occurrences, but

not with standards). Characterization of an individual's relevant knowledge, skills and wants (and his individual difference characteristics--see below) is just as surely a characterization of the constraints on his possible behaviors (recall M1, M2, M3 as principles of response selection) as would be provided by reference to underlying processes or structures, e.g., hypothetical "storage capacity", "mediational bonds", "channel capacity", "level of activation", etc. The evidence to date (cf "Persons", Part IV) indicates that any of these latter are paraphrases of some of the former, but not vice versa. Thus, as part of a "theory of performance", PIA is, on the face of it, the resource par excellence for saying "what actually happens" in human behavior.

(6b) Ever since the formulation of semantic theory in essentially its present logical form[11] the semantic theory of truth has served as the primary (philosophical) model of what a scientist is engaged in doing (he is searching for truth) and what he does it with (a theory which is a putatively true description of the world). That formulation was accomplished at the cost of an indefinitely deep stratification (in principle, infinite) of a given language into distinct languages (object language, meta-language, meta-meta . . . . etc.). This was done in order to eliminate self-reference and the logical antinomies associated with self-reference. But that reflects the limitations of semantic theory and is not plausibly presented as a feature of the phenomenon of natural language. Neither linguist nor layman, for example, would take seriously the

suggestion that, contrary to all appearances, English speakers really speak an indefinitely large number of distinct languages just because in English one can talk about talking about English in English, or because one can talk about what one is saying.

Psychologists need not take that suggestion seriously either, although the form and use of our psychological theories shows that in fact they have. After all, saying something is a form of human behavior, and if the natural phenomenon of a speaker saying something has a reflexive logical structure, then so must the general case of human behavior. That is precisely what is codified by the reflexive formulation of intentional action as the basic unit (in terms of content) and the universal law (in terms of use) of human behavior, and it is one of the most important things which our more familiar psychological theories fail to encompass.

(6c) Given that the rule-following model is primarily a formulation of use rather than content, a significant consequence of its reflexive character is the considerable simplification of a number of problems presented by limiting cases and boundary conditions in the use of psychological theories in the conduct of psychological science. For example, the methodological resources of the rule-following model are sufficient to deal with the following problems without requiring any ad hoc supplementations: (a) a theoretical boundary condition--"Well, you always have to make some assumptions"; (b) a subject-matter boundary condition--"You have to take the observation language as given"; (c) a technical boundary

condition--the necessity for giving a second description of "the response" or of "the stimulus" in the form of "cues", "controlling variables", "physical parameters", or whatnot; and (d) a methodological boundary condition--the necessity for exempting the psychologist from the scope of his application of his theory (see Bakan, 1965), together with the attendant necessity for a separate, non-psychological and even non-scientific, theory (our "philosophy of science") of scientific human behavior. Here we encounter the performance vs competence distinction again. Because scientific behavior involves an essential reference to standards, no causal-process theory (and, it would seem, no theory subject to the boundary conditions above) can provide an adequate conceptualization of that form of behavior (cf Wick, 1964).

(7) It should be clear that the rule-following model does not require an appeal to new kinds of facts in order to understand human behavior (though one might get greater mileage from the same set of observations--cf "Persons", Part III and Ossorio, 1966b). The facts adduced by the associationist, the psychoanalyst, the existentialist, and the operant conditioner, and the interpretations made of these facts by recourse to these theories are all, on the present evidence, intelligible within the rule-following formulation (cf "Persons", Part IV, V). The difference is that the rule-following model presents a greater logical complexity (e.g. reflexive vs simple descriptive) and a greater methodological scope (deals with both the pre-empirical and the empirical, rather than merely

the latter, and with both content and use rather than merely the former) within which existing theories may be represented as simplified limiting cases. The simplification may be carried out in three steps:

(a) Restrict the concept of "explanation" to include only those instances which have the linguistic form "X causes Y" or can be so paraphrased;

(b) Restrict the use of the conceptual apparatus to the simple descriptive use, excluding the occurrence of self-instantiation;

(c) Restrict the substantive terminology to new terminology, and to terms which are used ambiguously in regard to whether they refer to behavior or to a physical system.

(8) The use of a concept and the use of an underlying constituent structure are commonly assimilated to the paradigm of the use of a tool. Indeed, we often hear "Language is a tool for . . . (fill in the blank)". That is precisely the wrong assimilation. Compare the following: (a) He used the pliers to tighten the bolt; (b) He used patches of flaming colors to create a sombre effect; (c) He used a Ruy Lopez opening to win the first game. Reference to the colors in (b) and the Ruy Lopez opening in (c) are a way of distinguishing what was done, whereas reference to the pliers in (a) is a way of identifying what something was done with. Specifying the concepts, structures, or knowledge relevant to an intentional action is a way of specifying what action it was, not what caused it or what it was done with. Thus, references to what a

person knows (or wants or knows how to do) is not a reference to unobservables in a hypothetical realm called "mind" (see below), but rather, is our way of codifying our ability to distinguish one observable behavior (there is no other kind) from another.

(9) There is no general problem of "explaining behavior" any more than there is a general problem of "explaining physics" or "explaining the world" (see below on the rule-following model as a domain of discourse). There are, instead, specific problems having the form "Why this behavior (or this kind) here now rather than some other (or some other kind)?" Answers to such questions are given in accordance with the following maxim. M4: "The behavior that was engaged in was what it was because the circumstances of its occurrence were what they were." This maxim has a verbal form that is clearly parallel to that of a simple S-R formulation, and the parallel is a genuine one[12]. The difference is one of conceptual and methodological scope (see 7 above). The explanatory force of the "because" is not restricted to the causal paradigm, which could only connect events with events. (Among the relevant circumstances are the individual difference characteristics--see below--of the particular person whose action is in question). Circumstances do not produce behavior; rather, differences among circumstances are lawfully related to differences among behaviors, and that is why reference to the former helps us to understand the latter. And, of course, reference to circumstances is already contained within the person concept, e.g., in what the person "Knows".

The Individual Difference Paradigm (ID)

The intentional action paradigm represents only the "universal law" aspect of behavior, and that is what is primarily relevant to the present paper. It may be noted briefly that the second basic component of the rule-following model is the individual difference paradigm (ID), in which the constituent formal concepts are "trait", "attitude", "interest", "value", "style", "mood", "state", "status", "need", "ability", and "intentional action". More accurately, the second paradigm, which includes PIA, *is* the rule-following model, and it is the concept of an individual person.

The relation between PIA and ID is given by the following two summary statements: (a) An intentional action is what a person does; and (b) A person is an individual whose history is a history of intentional actions articulated into the individual difference format.[13]

Comments on ID

(1) The concept of a person, the ID paradigm, is the concept of a part-whole structure (a life history) in which the basic elements are behavioral process units (intentional actions) assimilated to one or more of the formal ID concepts listed above.

(2) This "assimilation" represents something quite different from mere classification. What is involved in any such assimilation is a logical function which, though not mathematical, is quite analogous to a mathematical function such as the "square root"

function or the "logarithm" or "sine" or other functions.

For example, to see an intentional action as being of type X (e.g. hostile action) is simply to classify it as being a particular case of PIA. To see that behavior as an expression of a <u>mood</u> (here, an "irritable" mood) is to see it as being an action which is different from either (a) one which is <u>merely</u> a type X action or (b) a type X action which is the expression of an attitude (here, a "hostile" attitude) or of any of the other ID formal concepts. The type X action which is the expression of a mood has a particular logical relation to one which is merely a type X action. The relationship is that of a functor (mood) to its argument (type X action). To speak of "the <u>mood</u> function of <u>hostile</u> action" is quite analogous to speaking of "the <u>square</u> <u>root</u> function of the number <u>two</u>". Just as we have no simple designation for the number which has the relation "square root of" to the number "two", for which we do have a simple name, we also have no simple name for the action which has the relation "expression of mood" to the action "hostile action", for which we do have a simple characterization.

And just as we classify together "square root", "sine", "logarithm", etc. as "mathematical functions", which take numbers as their arguments and have numbers as their values, <u>the formal ID concepts are correctly described as a set of logically interrelated "person functions", which take intentional actions as their arguments and have intentional actions as their values. Thus,</u>

the concept of a person is a domain of discourse, i.e., the domain defined by intentional actions and person functions, and is not merely a nominal categorization for a set of objects.

(3) As in the case of intentional action, the concept of a person is not used as a simple description of certain kinds of individuals (persons). Rather, it is the concept which one person uses in his intentional actions vis a vis other persons and himself. One might say: What makes an individual a person is not that the concept applies to him, but rather, that he applies it to others. But of course, if he does that, then the concept does apply to him. Thus, like PIA, which it includes, the concept of a person is a reflexive concept, and as with PIA, its primary function is as a computational device for transforming observations to actions rather than as a simple description of what is "out there".[14]

(4) The formulation of the rule-following model is responsive only to methodological considerations and never to merely technical ones. Thus, the introduction of an individual difference system is not merely a pessimistic concession to the fact that there is "error variance" associated with our current "universal law" formulations of behavior. Rather, it is a recognition that universal laws could not be applied (or discovered) except in connection with distinguishable initial conditions. Thus, if we take the familiar "nomothetic model" (Mischel, 1964) to be summarized as "universal causal laws applied to initial conditions", then, in much the same way as the rule-following model replaces "cause" with the less restricted

"because", it also replaces "initial conditions" with the more noncommital "individual differences", and the parallel summary may be given as "one explanatory law applied to particularized individuals".

(5) Within the concept of a person there are two "competence" concepts. One is the PIA concept "know how" and the other is the ID concept of "ability". There are crucial differences between the two.

(5a) To say that a person has the ability to do X is to say that there is a type of achievement, X, which we may expect him to accomplish if he tries. The ability to do arithmetic, to speak English, to hit a target, to walk from one place to another, to distinguish round objects from square objects, are examples. The fact of a person's having a particular ability is conceptually quite independent of any facts about how he came to have that ability.

(5b) To say that a person's doing Z represents the exercise of skills is to say that his performance was not the result of accident, coincidence, luck, or chance, and that he would be able to do it again in similar circumstances. The alternative to its being luck, chance, etc. is that it is something he learned to do--that is what backs up the expectation that he would be able to do it again. But to say that he learned to do this is only to say that his learning history was of the right sort, that it contrasts with possible other histories given which he would not now be able to perform as he does. In particular, what is not implied is either (1) that he can do

anything else, not even other, similar performances, or (2) that he has ever done before what we now say he could repeat.

For example, his bringing "War and Peace" from the third shelf to the desk is something he need never have done before in order for us to say that his doing so reflects his learning or that he could do it again. Of course, we might say that he acquired "visual motor skills," but that would be as noncommital as saying that a person has acquired "verbal skills."

(5c) Thus, the two "competence" concepts in the rule-following model have basically different roles in the system and provide characterizations which have a different basis and a different significance and explanatory force. Each provides a principle for grouping performances (i.e., those that are alike, and those which share a history) but there is neither guarantee nor presumption that any grouping arrived at via the "skill" concept will coincide (contain the same set of performances) with any grouping arrived at via the "ability" concept. There is therefore no presumption that the empirical laws which characterize performances grouped in one way will coincide with--or, indeed, bear any resemblance whatever to--the regularities associated with the other grouping. The "skill" characterization is essentially a historical one that tells us only that one of the necessary conditions for his doing Z to have been a case of intentional action at all has been met. The "ability" characterization is an essentially taxonomic one which tells us what his achievement was and informs us that he would also be successful in accomplishing other achievements which are different from this one but are nevertheless of the indicated same kind.

A General Comment on the Rule-Following Model

The preceding provides the needed backdrop for making the following summary formulation intelligible: Osgood is quoted by Dulaney (1967) as worrying that "It is one thing to use notions like "competence," "knowledge," and "rules" as heuristic devices, as sources of hypotheses about performance; it is quite another thing to use them as explanations of performance--unless, of course, one is ready to give up his behavioristic moorings entirely in exchange for a frankly dualistic mentalism."

The response to such a statement is provided by the rule-following model in three parts: (a) The concept of "behavior" is the same concept as the concept of "mind" and the phenomenon of behavior is identically the same as the phenomenon of "mind." Moreover, that single "phenomenon" is more aptly characterized as an entire domain of phenomena our independent access to which is codified by a characteristic form of discourse (the rule-following model). (b) A decisive turning point in the history of psychological explanation was the acceptance of the equivalence of "physical" and "observable" (a consequence of the ambiguity of "physicalistic"). The rule-following model corrects this gross and fundamental error. The great divide is not between "behavior" and "mental," but between "behavior" and "movement." In this respect it does not matter whether the movement is an inner, physiological one, a directly observable one, or an invisible, hypothetical one. What does matter is the logical status of these two concepts. Behavior is no more a species of movement than the queen of hearts is a species of cardboard. (c) It is one thing to use our technical competence at

manipulating physiological or broader circumstances so as to extend the _practical_ range of _our_ intentional actions, for example, in predicting or influencing the actions or personal characteristics of others; it is quite another thing to hypostatize this practical knowledge into a physiological or quasi-physiological underlying causal process _explanation_ of behavior--unless, of course, one is ready to give up his behavioristic moorings entirely in exchange for a frankly dualistic materialism.

Instead of making the a priori decision that one type of _observable_ phenomenon (physical or physiological objects, processes, events) is more real than another type of _observable_ phenomenon (behavioral processes, events, objects), the question of systematic relationships of detail between observables is left open to empirical investigation, and no sense can be made of any putative statement of _the_ general relationship between these major kinds of observables. There need not be _a_ general relationship.

Postscript

Some number of questions are bound to arise which could not be dealt with in a paper of limited scope. Perhaps it is worthwhile to indicate several points which are not difficulties but are likely to seem so: (_a_) The rule-following model does not apply only to adult human beings (another objection to "rational" models). A general methodological principle referred to as "paradigm case formulation" (cf _Persons_, Introduction) not only permits application to nonverbal infants and nonhuman animals, but makes that application intelligible. The urge for continuity does not here require the usual sacrifice of real differences. (_b_) There

is no priority argument of the form "But physics _is_ basic, after all, because everything is physical, but only some of the things within the physical world are persons." _Possibly_ "everything there is" can be expressed in physical terms (we cannot do it now). _Certainly_ "everything there is" can be expressed in psychological terms, _today_. There is no asymmetry here favoring physics. (_c_) The concept of a person is as culture-free as the concept of a physical particle or of a living cell or of arithmetic. But more than this, the concept of a person is what makes the _question_ of cultural relativity intelligible (e.g., by virtue of "status" and the other formal ID concepts generally) as well as providing the framework for obtaining empirical answers (specific ID characterizations) and codifying our limitations in this respect at any given time (competence and knowledge characterizations). There is nothing parochial about the rule-following model.

The Rule-Following Model and Transformational Grammar

Because the domain of human behavior is intrinsically dynamic, no special dynamic constructs are required (even "want" is not "dynamic" in the ordinary causal sense which is here seen as a degenerate case of intentional action). No causal constructs are needed, though some features of the model (see, e.g., the paragraph on "skill," above) could be formulated in causal terms. Because the basic formulation is "_this_ behavior, rather than some other because _these_ circumstances rather than some other," the major enterprise is to distinguish one behavior from another and to delimit intelligibly what qualifies as an instance of "behavior"

at all (recall that the relevant circumstances are built into the intentional action description itself). It is in this connection that the similarity to generative grammar and the continuity with generative grammar becomes evident.

Similarity to Generative Grammar

The task of generative grammar is to delimit intelligibly what qualifies as an instance of English (for convenience of reference only--it could be language X). A generative grammar of English is a set of rules for generating all and only English sentences. This is accomplished by a procedure which may be described as "instantiation". That is, the rules have the general form R1: "Any case of alpha is a case of either function 1 of $beta_1$ or $beta_2$ or . . . or $beta_n$ or function 2 of $beta_1$ or . . . or $beta_n$, or function m of $beta_1$ or $beta_2$ or . . . or $beta_k$." A special case would be R2: "Any case of alpha is a case of either $beta_1$ or $beta_2$ or . . $beta_k$." And an even more restricted case would be R3: "Every case of alpha is a case of $beta_1$ and $beta_2$ and . . . $beta_m$." For example, the initial formulation "S $\rightarrow$ NP + VP" has the form of R3 and may be read as "every instance of a sentence is an instance of a noun phrase and a verb phrase" (since there is only one such rule for S, there is no difference between "may be rewritten as" and "is a case of"). The further developments usually have the form R2; for example, "Every case of a noun phrase is either a case of a solitary noun or a case of a noun preceded by an article or . . ." Finally, the most detailed developments (e.g., transformation

rules) are likely to have the form R1.[15] Eventually, the substitutions have English words as their instances, and so, if we can distinguish one word from another, the grammar serves to identify which sequences of English words are English sentences.

In the case of behavior, we have a similar situation. The initial formulation is given by PIA, and it, too, has the form of R3, above. "B → W + K + KH + P" may be read as "Every instance of behavior is an instance of wanting something and knowing something and knowing how to do something and engaging in some performance". The latter is recognized as a paraphrase of the characterization of PIA, "in any intentional action a person <u>necessarily</u> (a) is trying to achieve something he wants, (b) has the relevant knowledge for making the attempt, (c) is recognizably doing the sort of thing one <u>would</u> do in order to achieve that, and (d) his doing that is neither accident nor coincidence (etc.), but the exercise of learned skills". The difference between the two formulations is that the latter makes clear that the permissible substitutions under any one of the parameters K, KH, W, and P are not independent of the permissible substitutions under the others. As in the grammatical treatment of S, the further developments of PIA have the form of R2. For example, any case of wanting is a case of either wanting x or desiring y or being anxious to get q, or being determined to avoid r, or . . . or having a reason to accomplish z. Finally, the most detailed developments have the form of R1. These occur when the ID paradigm is brought into play. "Angry action" is

a PIA description, but any angry action which is the expression of a trait is different from one which is the expression of a mood or the symptom of a state of the expression of an attitude or the manifestations of an ability or lack of ability, etc. It is important to the understanding of the rule-following model to see that the form R1 is exactly the right form for expressing the relationship between a particular intentional action and the individual difference format into which it is assimilated. Here, <u>the functions in question are person functions</u>. The analogous functions, the "transformations" of generative grammar, are, of course, <u>grammatical</u> function.

Clearly, there are limits to the similarities that can exist between a pragmatic system and any purely syntactic system. The force of the foregoing is that the similarities between the rule-following model and transformational syntax are part of the basic methodology of both. The similarities are perhaps best summarized by saying that both are <u>descriptive</u> in spirit and <u>instantiative</u> in their procedure. There is also a historical parallel in that the emergence of each presents a contrast to a predominant existing order of positivistic, reductive theorizing.

<u>Continuity with Generative Grammar</u>

One notable difference between grammar and intentional action is that, at least in gross description, there is a much tighter structure of internal constraints (redundancy) in connection with

intentional action than there is in connection with sentences. Whereas any substitution instance of NP may be combined with any instance VP and the result is still S, by no means is it the case that any combination of instances of W, K, KH, and P will be a case of B. "The colorless green idea slept furiously" is a genuine instance of S, but the combination of knowing the name of the capital of China, wanting fame, knowing how to ride a bicycle, and sucking one's thumb does not instantiate any intentional action.

The discrepancy between the weak constraint on sentences and the strong constraint on actions may be expressed in the following way: Not every sentence can be used to say something, and not every case of uttering a sentence, even a sentence that can be used to say something, is a case of saying something.[16, 17]

When a given intentional action is a case of a person doing something by means of saying something by means of uttering sentence s, specifying that it was that action is to specify, among other things, that he knew how to say something by engaging in a performance which is correctly described as "uttering s." If "S_1" is a grammatical description of s, then that performance would be correctly described as "uttering S_1" and we could then also say that that person had succeeded in uttering S_1 and that saying something by uttering S_1 was something that he had accomplished. There would be an important difference in that achievement depending on whether it was an isolated case or whether it was exemplary of his general

level of success with S. To describe his achievement as the expression of a particular ability and to identify that ability by reference to the grammatical theory of S is to provide the information that the second of these two alternatives is the case. Thus, one of the direct, substantive continuities between the rule-following model and a generative theory of grammar is that S may be substituted directly under the ID concept of "ability."

There are other connections that are worth noting. For example, if P's performance qualifies as "uttering S_1" then there are individuals, O, who know how to use S to describe performances such as P's. If such an individual, O, were to use S to describe P's performance, we could characterize O's behavior by substituting S or some derivative of S under KH in PIA. Of course, O would most likely be a grammarian. Other substitutions in PIA are also possible. For example, if a person drove home a point in linguistic methodology (that was his intentional action) by saying or writing "Colorless green ideas sleep furiously," we might very well find it impossible to articulate what action it was if we were not in a position to say that he knew about some of the underlying constituent structures in the grammatical theory of S. Here we would substitute S under K in PIA. Or again, the actions of a person who was trying to teach a child to speak English might require that we refer to the underlying constituent structures under W (that is what he wanted the child to master) in order to give an adequate accout of what he was doing.

Since the use of S as an ability characterization is applicable to entire populations of speakers whereas the substitutions under PIA apply only to exceptional individuals such as grammarians, the former is here regarded as the principal continuity between the rule-following model and generative grammar as a theory of linguistic competence. The PIA continuities reflect the fact that the rule-following model is a theory of performance as well as a theory of competence.

The Use of Grammatical Structures

We may now turn to the thesis that English speakers do not in general know how to use the underlying constituent structures of English, and so there is no general problem of explaining how it comes about that they do know how to do this. The basis for the thesis may be summarized by saying that the theory of S, including that portion which deals with underlying constituent structures, is a resource which some of us have for characterizing the linguistic achievements which all of us in the language community regularly accomplish, and as such, it has nothing to do with how any such achievement comes about. More briefly, the theory of S provides us primarily with "ability" characterizations and has at most an incidental and peripheral value with respect to systematic "skill"

characterizations.[18] In contrast, the primary task for learning theory is the systematic description of sufficient conditions for additions to (or subtractions from) a performance repertoire[19] i.e., "skill" characterizations. That is intelligible in terms of the formal distinction given above between "skill" and "ability" concepts, but it bears some illustrative elaboration. This will be given first by a heuristic analogy and then in a direct statement.

In those actions in which something is said, a statement of those competences of the person which were involved in that action would include reference to the particular one of knowing how to utter a sentence which is "on target" in that it 'says' what the person *says*. If that seems forced, compare: In those actions in which something is kicked, one of the relevant competences is that of knowing how to kick a selected target, rather than *merely* knowing how to kick and in sharp contrast to not knowing how to kick at all.

It is because there are human behaviors which qualify as "kicking X" that there are certain performances which qualify as "*merely* kicking." If we had no such behaviors as "kicking X" what we now call "merely kicking" would not then be what it is now, and we would not have the reasons we do, and perhaps no reason and no ability

at all, to distinguish anything as being <u>that</u> sort of performance. Likewise, it is because there are human practices of saying something by uttering words or sentences that it is possible for some performances to qualify as <u>merely</u> uttering words, or sentences. What characterizes merely kicking is that the performance is one which would have qualified as "kicking X" if there had been an X there to be kicked. Likewise, what characterizes the mere uttering of a sentence is that the performance is one which would have qualified as saying something <u>if</u> there had been anything of the sort to be said there then. (An intermediate case: Uttering the sentence "I now pronounce you man and wife" is a performance which would qualify as having performed a marriage if the speaker had certain ID characteristics, e.g., had the status of a minister, and if there were a marriage to <u>be</u> performed there then.)

Performances describable as "kicking" could be systematically articulated and described by mapping them into a geometric framework. We could then use that framework to distinguish one kick from another, identify kicks that had never been accomplished before, and recognize several instances of kicks that were "the same kick" under the geometric description even though there was no obvious visible resemblance. In exceptional cases, we might try to achieve a kick which was described only in terms of the geometric framework. Our level of competence at applying a geometric descriptive system in this fashion would be an empirical matter largely unrelated to our kicking practices and no doubt would change in the course

of our social history (it might increase, decrease, fluctuate, vanish, etc.). However, whereas we should want to ask how a person learned to kick something, we should hardly want to ask _what it was he learned that enabled him_ to satisfy particular geometric descriptions.

We should hardly want to ask that because we should not know _what_ we were asking or whether we were asking anything at all by uttering those words ("Do colorless green ideas sleep furiously?"-- is anything being asked here?) For the only answer that we know makes sense is the one that was already given. That is, _what he learned was how to kick something_, and having an answer (if there is such a thing) to our _new_ question (if that is what it is) is not a condition for understanding or explaining _that_.

The new 'question' here prejudges a crucial issue. What enabled him to satisfy those geometric descriptions was not some additional thing that he learned how to do, but rather the additional _fact_ that doing that was the same as kicking something, the latter being something he surely did know how to do. The opportunity for bringing it off lay in the circumstances by virtue of which doing the one was the same as doing the other. The achievement lay with us, the observers, in _seeing_ (or arranging it) that doing one was the same as doing the other, not with him in bringing it about, for there was nothing other than kicking something that _he_ had to accomplish in order to satisfy those geometric descriptions.

To be sure, it might be of some interest to plot empirically

the course of a person's learning to kick X, using the geometric frame of reference for plotting the successive achievements. But it would be highly misleading, if not actively irrational, then to turn around and suggest that his having learned to kick X is accounted for by his having learned the succession of achievements (or any function thereof) which we plotted. And if the empirical information could be summarized in a general formula which was successful across persons (a mathematical model of kick-learning) it would make no more sense then to say that his having learned to kick X is accounted for by his having learned whatever we might say the formula signified. S-R and other underlying process theories of learning may be characterized as attempts to find that magic formula. There need not be any. In contrast, operant conditioning formulations are likely to be directly relevant to "skill" characterizations. The operant conditioning emphasis on training procedures, as contrasted with hypothesis testing, makes possible some relatively unambiguous coordination of present know how and past learning episodes.

Psychological theorists have commonly taken the kind of position that is exemplified by the thesis that there has to be an answer to the 'question' of what that kicker learned that enabled him to satisfy the geometric description, and that we must have an answer of this sort in order to understand, i.e., have a scientific explanation of, his coming to be able to kick (see, e.g., Miller, 1965; Fodor, 1965). One reply would be to point out that to

equate understanding X with having an explanation of X would leave us with an infinite regress from which nothing could emerge. We block the regress by recognizing that unless an explanation for a phenomenon _already_ exists, there is nothing of _that_ sort about the phenomenon that we have failed to understand if we do not have _that_ explanation.

But there is a second form of reply which is perhaps more instructive. That is that the thesis appears to represent a simple logical error the nature of which is well codified in the literature of logical theory as the problem of preserving truth under substitution. In that literature there is no serious challenge to the conclusion that if (a) I believe that that object is a lion, and (b) that lion is in fact harmless, it does _not_ follow that (c) I believe that that object is harmless. The feature of not preserving truth when something is substituted in a true sentence for something else that is "the same" is a common characteristic of "mental" or "intensional" phenomena. For example, the human activities which we describe by reference to "believes X", "knows X", "means X", "wants X", or "intends X" have this characteristic. The logical error to be pointed out here lies in not recognizing that "learned how to do X" and "knows how to do X", have this feature also, whereas "achieves X" and "is able to do X" and "succeeds in doing X" do not have this feature. Note that in none of the following does (w) follows from (u) and (v), even where (y) might be demonstrably the case:

(a) u. I learned how to pick red hats from other hats.

v. The red hats are the same hats as the French hats.

w. I learned how to pick out French hats from other hats.

y. I regularly succeed in picking out French hats from other hats.

(b) u. I know how to kick a field goal.

v. To kick a field goal is to satisfy the differential equations "E".

w. I know how to satisfy the differential equations "E".

y. I regularly achieve satisfaction of the equations "E".

(c) u. I know how to pitch a strike.

v. To pitch a strike is to satisfy the geometric description "G".

w. I know how to satisfy the geometric description "G".

y. I am able to satisfy the geometric description "G".

We do not need a long list of examples. "Knows how to do X" has the non-substitutivity feature because "intends to do X" has it. It is not a mere matter of fact, but a conceptual necessity that whatever I know how to do I can also intend to do and that what I do not know how to do I also cannot intend to do (though I may wish, try, hope, succeed). It is precisely that conceptual necessity which is codified by formulating "know how" as a parameter of intentional action. The fact that not merely wanting, knowing, and intending, but also learning and the basic form of competence have the characteristic mark of "mental" phenomena" is

part of the force of saying previously that the concept of "behavior" in psychology and the concept of "mind" are the same concept.

The moral to be drawn from the "nonsubstitutability" feature of competence concepts is that if P does X (an intentional action description) or if P knows how to do X (a competence description) neither such fact will be explained or even demonstrated to be the case by virtue of any one or more facts of the following sorts: (1) Z (an underlying process or event) occurs; (2) P accomplishes Z; (3) accomplishing Z is <u>in fact</u> the same as accomplishing X; (4) P knows how to do Z. Action and competence descriptions are what we establish by observation definitively and independently of any underlying processes. It will follow that achievement and learning which can be expressed only in hypothetical causal underlying process terms can be related to human behavior only as potential references to empirical correlates or as more or less redundant technical paraphrases, but not as having any explanatory force. The substantive value of any such hypothetical process whose hypothetical function is to "explain" behavior is therefore entirely questionable.

The alternative to supposing that psychologists who have opted for learning "mechanisms" underlying our demonstrated skills and abilities have made a crude error is to say that in fact they have tried to <u>deny</u> the failure of mental phenomena to preserve truth under substitution, probably without knowing that this is what they have been doing. This is to say that they have tried to treat persons as non-persons, and more specifically, as material objects,

since it is in statements dealing with material objects that we do find truth preserved under substitution. This is the move that is implicit in the standard format for a psychological behavior theory, where cognitive, motivational, and associational "factors" or "processes" are represented as the causal antecedents of behavior (where "behavior" = "movement", but implicitly so, and disguised by the ambiguity of technical terminology). And this is part of the force of saying that any causal-process account of behavior, be it of the SR, psychoanalytic, or operant conditioning variety, will, if we take literally and seriously instead of merely exploiting it for whatever practical and heuristic value it may have, require that we give up our behavioristic moorings entirely in exchange for a frankly dualistic materialism.

It merely remains to translate the heuristic analogy into a direct statement: Performances which qualify as "saying something" could be systematically articulated and redescribed by mapping them into a set-theoretical frame of reference. We could then distinguish one case of "saying" from another, identify cases of saying that had never been accomplished, and recognize cases of saying which were "the same" under a grammatical description which might be as cumbersome as one might imagine (for example, it could be replete with underlying constituent structures). However, whereas we should want to ask how a person learned to say something, we should hardly want to ask what it was he learned that enabled him to satisfy that grammatical description. For if there is any

answer to that, then considering the *derivation* of the grammar from linguistic performances, the only answer that we know makes sense was already given--he learned to say something. (There *is* a different sort of question that makes sense, i.e., "How come he learned?", and the historical-circumstance answer to that might well be "I taught him". Descriptions of causal connections translate into possible intentional actions, a fact which is exploited but not systematically formulated in operant conditioning.)

To be sure, it might be of some interest to us to use the grammatical descriptive system as a frame of reference within which to plot the course of his learning how to say things. (That would be like plotting the course of a person's Rorschach responses over his formative years, using the Rorschach conceptual system of "content", "movement", "form level", etc. as a framework.) But it would be highly misleading then to turn around and suggest that his having learned to satisfy certain grammatical descriptions is what *enables* him to say things or what *accounts for* his saying things. If the empirical information could be summarized in a general formula, e.g., a grammatical rule or set of them, we might summarize our findings by talking about the set of rules (or, e.g., underlying constituent structures) whose e he had acquired. But there would be no more point than previously in asking what it was that person learned that *enabled him* to follow that rule or use that underlying constituent structure.

What is commonly overlooked is that "competence" concepts have

essentially the same significance within the domain of behavior that mechanisms used to have within the domain of physical particles before they were replaced by deterministic rules in quantum mechanics.[21] That is, they provide stability, regularity, predictability in the transition from one state of affairs to another within the domain in question. This is why when a materialistic predilection leads us to look for "mechanisms" in behavior, our answers may have some heuristic value. But that is also why mechanisms are superfluous. One might say, they are epiphenomena relative to mind or behavior.

Conclusion

The view presented here is that although linguists appear to be justified in appraising current associational learning theories as inadequate to deal with the problem of the acquisition and exercise of underlying constituent structures in language, psychological theory is in no such straits, for with respect to the latter there is no such problem to begin with. Very likely, this conclusion will be unacceptable to both the linguists and the psychologists who have been involved in the recent disputes. For the linguists, despite their anguish, have been asking for psychological mechanisms from psychological theory, whereas on the present account it is their function to articulate something akin to mechanisms for psychological theory. And of course, it would be difficult for an associationist to accept the conclusion that his theory is

fundamentally inadequate. The present discussion may, however, be both informative and of some comfort to those perplexed but not so innocent bystanders whose primary concern is with the implications of the transformationalist-associationist dispute for an appraisal of the present and prospective state of the art in our accounts of human behavior.

FOOTNOTES

1) The present paper reflects the many helpful suggestions and critical comments by Keith E. Davis and Lyle Bourne in connection with earlier drafts.

2) We do not have any familiar pragmatic theory to serve as a model or as a paradigm case, and so saying that the rule-following model is a pragmatic theory is less of a positive help than a warning not to confuse it with a putatively true description of human behavior.

3) Some examples of complex concepts: "baseball", "person", "number", "physical object", "automobile", "science".

4) The distinction in linguistics is closely parallel to the psychological distinction between "learning" and "performance" and to the more down to earth distinction between what one knows and what one does.

5) In earlier formulations either "overt attempt" or "try to get" have been used in place of "performance".

6) "Wants" and "has a reason" are here used interchangeably, with appropriate grammatical changes.

7) The latter is the usual format for a psychological theory.

8) The required qualifications are not to the point here.

9) This is the reflexive use, the "pragmatic model". See Ossorio and Davis (1967) for an analysis of "self" concepts in terms of the rule-following model. In the current computer implementation of the rule-following model, this feature is referred to as "observer focus", since the individual whose behavior is to be reproduced is himself necessarily an observer.

10) Even this is misleading if it suggests that what is observed is "given" or is "input" or that PIA refers to something which occurs after observations and prior to behavior. The transition in question is more accurately described as a transition from one behavioral state of affairs to another. This is why a computer system, which is a rule-following individual (artifact) is the "natural" technical implementation of the Person concept.

11) See Carnap, 1958, for a recent formulation.

12) Kimble's (1967) position in discussing "the basic tenet of SR theory" is that M4 literally does represent the significance of the S and the R in SR theory, and that the causal-process and physiological-substrate implications commonly associated with SR theory are really extraneous. Since he takes M4 to be a self-evident description of the facts of psychology he concludes that therefore any psychology must be an SR psychology. (By no coincidence, the systematization of the rule-following model is part of the more extensive task of providing the initial

substance of a new, foundational psychological discipline designated as <u>Descriptive Psychology</u>.) Kimble's conclusion will probably be rejected by non-SR psychologists as being simply imperialistic. However, reflection upon it shows it to be the same conclusion as the following: <u>There is no such thing as an SR psychology</u>, and to speak of either "stimuli" or "responses" is, <u>substantively</u>, entirely gratuitous. In the latter form, Kimble's conclusion may be generally acceptable.

13) Again, there are relevant qualifications to be given <u>within</u> the system.

14) See footnote 9.

15) There are variations of R1 and R2 which are not to the point here.

16) That is how antinomies are dealt with in a pragmatic, reflexive system--a person who utters one of <u>those</u> sentences is not saying anything.

17) Saying something is logically prior to uttering sentences, even though the latter is an activity which has systematic extensions beyond the former. The priority is best given via a "paradigm case formulation." That is illustrated below in the reference to "merely kicking." For the present, we might say: In terms of Morris' (1938) classic distinction, syntax is an abstraction from the phenomenon of language, and semantics is also such an abstraction, but pragmatics deals with what that phenomenon <u>is</u>. Intentional action and the rule-following model qualify as a pragmatic formulation in Morris' sense, and in this sense are logically prior to grammatical abstractions.

18) The general case of an ability description or an achievement description is a third person description. That is, in general, what a person may be said to accomplish depends on the descriptive apparatus available to an observer. The number of different <u>and</u> <u>incommensurable</u> descriptions of what a person accomplishes, even, what he <u>regularly</u> accomplishes, is potentially unlimited. It would be both methodologically reckless and anti-empirical in spirit to insist in advance of demonstration, that all such descriptions can be derived analytically as outcomes of a learning process at all, much less of a single learning process. However, we do need some way of identifying particular kinds of performances, and a grammatical description would be one such way. The experimental paradigms of learning theorists provide another such way. Neither has any <u>guaranteed</u> value.

19) One of the fundamental facts for the intelligibility of learning theory is that although behavior is generally "overdetermined" in terms of motivation, it is certainly "underdetermined" in terms of learning. Although the number of distinguishable human behaviors is unlimited (even the subclass of verbal behavior has this feature) the number of distinct learning episodes is certainly quite finite. A given learning episode or set of episodes must, in general, account for a multiplicity of performances and performance capabilities, hence the central place of the concept and problems of "generalization," "transfer,"

"inhibition," etc., in learning theory. But also, this is why a "know how" parameter is an indispensible part of the concept of behavior.

20) As indicated previously, neither domain is more extensive than the other. Persons are commonly regarded as peculiarly complex physical objects, but it is no less apt to regard physical object as peculiarly simple persons. The proper question is not <u>whether</u> one or another of these characterizations is true, but rather <u>when</u> is there a point in using one or the other characterizations

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Appendix Q

LRI Report #4A

Outline of LRI Report #4 ("Behavior Description")

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Section I. Outline of "Behavior Description"

Part I. The primary contribution here is the delineation of "object," "process," "event," and "state of affairs" as purely formal and systematically interrelated concepts (analogous, for example, to "addition," "subtraction," "multiplication," and "division"). The formal character is shown by presenting in content-free form the interrelationships among the four in the form of "transition rules" for moving from one of the four forms of description, e.g., an "object" description, to another description of a different form, e.g., a "process" description. Recognizing these four (object, process, etc.) as parameters of our observations and descriptions rather than as the external realities which are the objects of our observations and the referents of our descriptions leads to the following developments:

1. No application of these concepts is identifiable as having any methodological priority -- no more than any application of arithmetic to particular content or in particular kinds of measurement could possibly qualify as being its basic application. In particular, physical objects (process, etc.) are no more basic than psychological objects (processes, etc.). Perhaps when the millenium comes, everything will be actually expressible in physical (physiological, etc.) terms. But then, on the basis of "Persons," everything can be expressed in psychological terms, with no trouble, and today -- and so what? That is not a basis for asserting priority.

2. A priori assumptions that physical references are basic has led to various theses about parsimony in psychological theory and to

various linguistic practices associated with these theses. Example: "But we don't _need_ to talk about intentional action in order to carry on a scientific study of behavior, and so it's unparsimonious to say that intentional action is an essential or useful psychological construct." Answer: We might arrange it so that we would not need to talk at all in doing science -- and so what? What one needs to say in the course of carrying out an activity (e.g., baseball, "scientific" psychology, or psychotherapy) must be sharply distinguished from (a) what one needs to say in order to give an adequate account of that activity, and (b) what _someone_ needs to be able to say in order that there should be any such activity at all. For psychological explanation it is these latter that are crucial, whereas discussions and theses regarding parsimony have focused on the former.

3. The notion of a "referent" has no present net value anywhere outside of technical semantic theory. When a "referent" is said to be a portion of the real world to which some of our expressions refer, that is simply unintelligible if it is taken simply and literally. The specification of the referent, B, for the locution, "A," is simply the exercise of linguistic competence with respect to the locution "B" and does not represent a prelinguistic access to reality. There is symmetry here such that we can also say that A is the referent of locution "B." The competence involved is the competence to say that this object (process, etc.), A, is _the same object_ (process, etc.) as this object, B. That is quite different from saying that A is merely B or that A is _really_ B. This formulation lays the basis

for a non-reductive "Unity of Science" position foreshadowed by Part II of Felknor's paper on activity description.] The argument that infants and animals demonstrate the phenomenon of "prelinguistic access to reality" is dealt with via a paradigm case formulation (cf. the discussion of "aware of x" and "aware that X is the case" in "Persons," Part I).

4. We could not possibly observe every object, process, event, or state of affairs which we can identify or talk about, not even those which we say are actually <u>observable</u>. Consequently, (a) reality (which consists of objects, processes, events, and states of affairs) has an intrinsically hypothetical, linguistic aspect, (b) we are necessarily limited in our ability even to <u>try</u> to confirm statements about observed objects, etc. (including even statements to the effect that this <u>is</u> such and such an object, process, etc.), (c) for a piece of human behavior to qualify as a test of the truth of some statement, or even as an attempt to do so, it must conform to standards of rational (intelligible) performance, just as any skilled action must, including the condition that (d) a truth-testing performance, though it may be part of another truth-testing performance, is intelligible at all only as being ultimately part of a more inclusive activity which is not a truth-testing activity, so that (e) demands for empirical verification do not carry a constant methodoligical weight, (f) our present methodoligical double-standard in which a demand for verification always takes precedence over an assertion <u>could</u> not be consistently applied, and (g) the more general basis for evaluating or making investigations (verifying) is our standards of rational

behavior, which are neither as amorphous nor as much like computer logic as is frequently supposed.

5. Finally: our attempts to understand and explain what we observe consist largely (perhaps entirely) of making the transition from one description (object, process, etc. description) of what we observe to another description (object, process, etc.) in accordance with the transition rules. This helps only if the redescription is one which we already know how to use. That is, if the new object, process, etc. is one of those from which we already know what to expect. Thus, the popularity of "models" and the compellingness of underlying process theories in psychology, since we "know" that whatever behavior occurs, there is a physiological description of the same object, the same process, etc. When we talk computers and mediation, we talk "as if," but when we talk of physiology we are likely to say "that's what behavior really is."

Part II. The foregoing evolved as a necessary preliminary to an attempt to clarify the difference between "skill" and "ability." Part II begins with a set of summary statements regarding the following concepts and some of their interrelationships: skill, activity, social practice, performance, institution. This section is an attempt to map out the various forms of behavior description (as contrasted to "Persons," where the parameters of behavior description are presented), hence the title of the report, "Behavior Description." The summary statements are elaborated into a discussion of the following topics:

1. "Skill as tied to the individual's learning history and an achievement which identifies that history vs. "ability" as tied to

an achievement which demonstrates the ability and to an achievement description which classifies the achievement and identifies what ability it is. The difference is crucial in regard to what an individual may be said (a) to know how to do and (b) to have learned to do, as against (c) merely to have succeeded (even, consistently succeeded) in doing. Some of the implications of the distinction between "knowing how" and "being able to" are developed in Appendix C of "Persons."

2. The question of standard and non-standard performances. The implication of a standard performance (i.e., of meeting performance standards, not of giving a stereotyped performance) is built into our normal ability or skill descriptions. It is misleading, rather than flatly incorrect to say simply "he knows how to do X" (e.g., how to get from one place to another) when he can do X only in a grossly non-standard way (e.g., by crawling, or again, by moving one inch per hour). This is because (a) ordinary skill or ability descriptions serve the function of telling us what else to expect from the person, (b) there is a limiting case (e.g., moving one's arm) where there is no difference between performance and achievement, and (c) skills and abilities are never absolute--unless our references to them are otherwise qualified, they carry the qualifier "under normal conditions." [Parenthetically: hence the possibility of "controlling behavior" by setting up special conditions.]

3. The "generative" character of all skills, not merely (as one might suppose from reading Miller, Chomsky, Fodor, et al.) verbal skills, and the question of whether "belief" (and the associative

concept of "truth") can be replaced by the concepts of action, attitude, and rule-following.

4. The problem of the acquisition of skills and abilities (and knowledge and motivation). Here we have a "Developmental Paradigm" which is a purely formal transition schema arrived at deductively from the paradigm of intentional action presented in "Persons." The limiting case is the infant who could be said to be completely lacking in both skills and knowledge, hence in motivation also. If he is able to succeed <u>enough</u> (and parents ordinarily see to that), he acquires both knowledge and skills even though he hadn't any to begin with. If he has some, he acquires more either by succeeding, as in the original case, or (primarily) by making use of what he already has. Since to distinguish X from Y is to create the possibility of wanting X rather than Y, motivation develops apace.

It turns out that this schema applies not only to child development, but to behavior change generally, including psychotherapeutically induced change. Parenthetically, the schema exhibits "self-actualization," "functional autonomy," curiosity," and "competence motivation" as system principles rather than as peculiar sorts of motives or mechanisms. Thus, we have an account of why an individual consistently and persistently acts in these ways (and why these are said to characterize the "normal, healthy personality") without the very implausible supposition that he somehow distinguishes this way of behaving and <u>wants</u> to do it or that he somehow <u>knows</u> <u>how</u> to behave that way. Some of this is already worked out in the discussion of Allport in "Persons."

5. A comparison and delineation of five major forms of behavior description (performance, activity, action, social practice, institution). Apart from carrying through the distinctions and characterizations systematically, the major point here is that these forms of description are just that and not references to different phenomena (not names of different "referents"). Two parameters for distinguishing among descriptions are (a) scope of the context or phenomenon (e.g., "social practice" descriptions refer to patterns of behavior which generally are more extensive [in space, time, complexity] than intentional actions) and (b) degree of commitment (e.g., a performance description is noncommittal relative to the corresponding action description, and an activity description is noncommittal relative to the corresponding action description or social practice description).

A good part of this discussion follows closely the content of Part II of Felknor's paper. His aim is to give event-sequence descriptions of two or more activities in sufficient detail to show some identical constituents and patterns, i.e., to show that two activities are going on at the same time and in virtue of the same set of events. This is a strategy for elucidating some of the non-obvious (including pathogenic) things that go on in families at the same time as some other, obvious things are going on. But clearly, it is a strategy which is "in principle" applicable to behavior generally, including psychotherapy in its "know how" aspect, and is applicable where one of the activities in question is a physical (physiological, etc.) activity. Hence the possibility of "Unity" in science without the metaphysics of reductionism. This position goes beyond the familiar

"double language" position in setting the requirement (and showing a way) of saying specifically what it is that is "the same" in particular cases.

6. One line of development extends the analysis of behavior description to the problem of "covert behavior," including, importantly, "thinking." The line developed here is that to say that someone is thinking is not to give a straight-forward description of something hidden, covert, or very subtle, but rather, it is to give a very noncommittal activity description of what that person is doing. To illustrate this, I've taken the closing section of Lyle Bourne's paper on thinking, with which I am in general agreement, and revised it "as I would have written it." Given this kind of conclusion, it becomes a practically important but methodologically trivial task to establish whether specific other activities (e.g., physiological) regularly accompany thinking, and if so, the degree to which manipulation of one contributes to our ability to control the other.

Section II. Expansion of I_1, I_2, and I_3 of Outline

Introduction

The present report is intended as a systematic elaboration of the material presented in LRI Report No. 3 ("Persons"). In the first section ("What is Observed") the discussion of description (Introduction and Part I of "Persons") is taken as a starting point and the descriptive system which forms the basis for observation is summarized. This descriptive system consists of the concepts of object, process, event, and state of affairs and their interrelationships, which exhibit a degree of completeness and coherence reminiscent of classical set theoretical systems. An examination of this system provides some further clarification of the significance of the Person concept in respect to such perennial topics as observation, explanation, reductionism, "language and reality," and parsimony.

In the second section ("Behavior Descriptions") a systematic account is given of the variety of structural forms of behavior descriptions and additional associated concepts. Here the concepts of action, social practice, activity, performance, achievement, skill, and ability are examined and presented. The frequently bewildering spectrum of interrelationships among such concepts is found to exhibit a degree of orderliness which reflects their articulation within the Person concept and the "observation" concepts. (Indeed, the identification of the observation concepts came about as a result of insights and problems associated with earlier attempts to systematize behavior descriptions.) In turn, the conceptualization of behavior description is extended to encompass

the formal aspects of thinking and personality development.

Misgivings in regard to the "authoritative" tone of the report are referred to "Persons" (Introduction, and Appendix A).

I. What is Observed

We have noticed that making an observation is no such simple thing as "reading off the features of what is actually there." We have noted, too, that neither infallibility nor universal agreement is characteristic of observation. Some further complexity is revealed when we ask what, most generally described, do we observe? The paradigm case of observing an X is to know that it is an X, to be able to say that it is an X, and to be able to treat it as an X rather than a Y or Z. Our abilities in this respect are codified by a particular set of concept-types. What we know how to recognize a thing as and treat a thing as is (a) an <u>object</u>, (b) an <u>event</u>, (c) a <u>process</u>, and (d) a <u>state of affairs</u>. To say that we observe such things is to say that there are exemplars of each sort which we come to know about on occasion without on that occasion having to find out something else first. For example: (a) I see a table, a person, an automobile, a body of water. (b) I see an automobile stop, a person smile, a window shatter. (c) I feel the water become hot, see the sugar dissolve, hear the fly come in this window and out that one. (d) I see that there is a chair in the room, that the motor is lacking a carburetor, that he has finished third in a five-man race.

The four concept-types are by no means unrelated, for we have ways of redescribing exemplars of each kind as exemplars of the other kinds. The transitions are made in accordance with the following rules, which do not necessarily represent a minimum set. Because the rules may be applied

successively, and some are recursive, considerably more than ten sorts of transition are possible.

A. Basic transitions.

1. A state of affairs is a totality of objects and/or processes and/or states of affairs.
2. An event is a change in a state of affairs.
3. An object is a state of affairs having smaller objects as constituents.
4. A process is a continuous change in a state of affairs.
5. An object does not change. [To represent a change in an object, we first transform the object into a state of affairs (see 3) and within that context introduce an event (see 2) or a process (see 4).]
6. The immediate constituents of a process are processes. (A process divides into smaller processes.)
7. The occurrence of an event is a state of affairs.
8. The initiating or terminating of a process is an event.
9. That a state of affairs is similar or different in particular respects from another state of affairs is a state of affairs.
10. Every object, process, and event is a constituent of some state of affairs.

B. Limiting cases.

1. The state of affairs which includes all other states of affairs (i.e., the world).

2. A set of objects which have no constituents (ultimate constituents; basic building blocks).
3. A process in which nothing changes (an object or state of affairs which <u>persists</u> unchanged).
4. A process which has no parts, i.e., is an event or something like an event (e.g., a unit class of events).

C. (Informal) Characteristic features.

1. Objects have histories and are embedded in states of affairs, along with other objects.
2. States of affairs have histories consisting of a succession of preceding states of affairs.
3. A process has an outcome, which represents the difference the process makes in a state of affairs which includes the process.
4. Any two object constituents of a state of affairs are related in one or more ways which go beyond co-constituency and its formal consequences. These relationships may be, e.g., geometrical, economic, emotional, kinetic, or any others appropriate to the types of object involved. Similar considerations hold for events, processes, or states of affairs which are part of a given state of affairs.

Certain aspects of this set of transitions and its use may be worth noting explicitly:

1. Content-free concepts.

The reference to objects, processes, events, and states of affairs is entirely content-free. The significance of "object," "process," "event," and "state of affairs" is purely formal, not substantive. One might say, these are to be thought of as book-keeping concepts, along the lines of "profit," "entry," "balance," or "asset," rather than production-line concepts as exemplified by "steel ingot," "worm gear," or "switching assembly." For example, it is not that "an event" is a descriptive term which we use to characterize the occurrence of something, where that occurrence is already known or observed. Rather, to see something as having occurred is to have seen something as (and treated something as) an event rather than as, e.g., an object.

In particular, an event, object, process, or state of affairs is not ipso facto a physical event, object, etc. Physical events, objects, etc. can be designated only by introducing an additional condition, i.e., that the domain of discourse is that of physical objects (the use of a distinctive descriptive system by Persons is constitutive of a domain of discourse) rather than, e.g., that of numbers, prices, or psychological objects. And, of course, nonverbal practices go with significant verbal practices. Some ways of treating something as an object qualify as cases of treating something as a physical object; other ways of treating something as an object qualify as cases of treating something as a psychological object (a Person) or as a biological object, etc. Because these differences are systematic, we speak of, e.g.,

person descriptions and physical object descriptions as representing the use of distinctive descriptive systems.

The substantive neutrality of the four "bookkeeping" concepts has a historical significance as well as a methodological significance. One of the most pronounced cleavages of thought in the domain of "philosophy of mind," hence also in "philosophy of science," at the present time involves the semantically oriented positivists and post-positivists on the one hand and the pragmatically oriented "ordinary language" philosophers on the other hand. One factor which has made a very apparent contribution to this cleavage has been that the positivists have assimilated everything that can be observed to the expression "physical," "material," or some equivalent (cf. "physicalistic language"). Thus, from the postulate that science is empirical (i.e. observationally based) they have moved to the conclusion that scientific discourse has an indispensable "physicalistic" component and thence to the further conclusion that all scientific statements can be expressed in <u>physical</u> terms. To be sure the last conclusion is merely "in principle," for clearly, nothing of the sort can now be accomplished. Nevertheless, the transition from "observational" to "physicalistic" to "physical" has made it possible for positivists to attain considerable conviction in the "in principle" argument and in the disparagement of other views as irrational (cf. Brodbeck, 1963). Naturally enough these positivistic tactics and conclusions have defined the standards for "rigor," "hardheadedness," and general respectability in psychological methodology.

"In principle, everything can be expressed in physical terms." "The human body is merely a complex physical object." "Reports of sensations refer to brain processes." These are familiar expressions of the assimilation of "observational" to "physical." It is only recently that this assimilation has begun to be subjected to an explicit frontal attack. For example, Long (1964) has argued that the "question" of whether _a human body_ is a physical object cannot even be formulated and so is not a question at all (no more, for example, than the 'question' "What's trumps?" can be formulated as a question _about a chess game_). Perhaps it is time to go further and introduce the symmetric counter-argument: _In principle everything can be expressed in psychological terms._

It should be quite clear from the prior formulation of the Person concept, with special reference to the technique of paradigm case formulation (Ossorio, 1966) that there is nothing whatever to prevent us from reformulating physical theories as statements about Persons of a particular kind (i.e., physical particles) whose difference from the persons we are familiar with is codified primarily as a status difference (i.e., a PII, or "individual difference" description). And although, like its counterpart, this is an "in principle" argument, it is _quite_ different in that it could be done today and with no difficulty whatever.

We may regard it as a historical accident, including the fact of residual emotional and polemic liabilities associated with "anthropomorphism," that many psychologists are trying to contribute to our understanding of Persons by trying to treat them as

non-persons, whereas few physicists are trying to contribute to our understanding of physical objects by trying to treat them as Persons. Ordinarily, psychologists who take this tack do so on the grounds of "parsimony."

"But we don't need to talk about 'wants' in order to describe or control behavior," is a paradigm locution for the advocate of 'parsimony.' But we do. To be sure, he (or they) need not talk about wants or wanting in order to control someone's behavior. But then, neither does he have to talk at all in order for what he does to be a case of controlling some behavior. (See the discussion, below, of "the knight took the pawn"; see also the discussion of "they are playing Bridge, only they don't know that that is what they are doing" in Part III of Persons.) And for the description of behavior, he might say merely "behavior," rather than make relatively unparsimonious references to variables," "responses," "operants," "cues," "habit family hierarchies," etc. But he would have to say that, too, not merely utter certain sounds. And if his merely uttering those sounds were itself merely a case of controlled behavior, then all the more evidently, nothing which qualified as giving a description would have taken place.

The issue of parsimony is in part the issue of when we have adequately described what we are doing. A psychological investigator whose major form of activity was conducting learning experiments or "shaping behavior" might respond to the question, "What are you doing?" by replying, "I'm doing science." For another investigator of his own genre, that would be enough, for the latter

would already know what "doing science" amounted to when it was <u>that</u> person who was doing it. And if the reply was "training two groups on a double-alternation problem," the second investigator would not need to be told that this was a case of "doing science." (Similarly, participants in the game do not need to be told that announcing trumps is a case of "playing bridge.")

Clearly, what is missing for the "parsimonious" investigator is the distinction between (a) what he has to say to another, similar, investigator in order to be understood, and (b) what has to be said by him or anyone else in order to give an adequate account of what he is doing. Professional locutions (theories, theoretical terminology, technical terminology) are what is required for a given set of professional social practices to be carried off. In the case of baseball, the requirements would include such locutions as "play ball," "strike one," "safe," and "ball three." In the case of investigating learning, the requirements might include such locutions as "operant," "rate of responding," "the controlling variable was X," and "under a fixed-ratio schedule."

Since the use of professional locutions is <u>part of</u> the social practices which constitute a given genre of scientific or other professional activity, such locutions carry no presumption whatever as to their suitability for <u>describing</u> those practices or activities. In general, other locutions are required. For example, in baseball, some reference to "inning," "team," "win," "umpire," "pitcher," etc. is required in order to say what is taking place,

whereas none of these locutions is <u>required</u> in the course of playing the game. In general, professional locutions omit reference to what can be taken for granted by the participants (hence they have the character of partial-descriptions--see Persons, Part I), and what is universally taken for granted is that it is persons who are engaged in the activities in question. But it has been pointed out (Persons, Introduction) that for a person to be engaged in a professional activity, e.g., the activity of providing accounts of human behavior, is for him to be engaged in a form of human behavior, hence any set of professional locutions which necessarily makes no reference to <u>this</u> form of human behavior is ipso facto inadequate for a general account of human behavior. This is a consideration that is peculiarly relevant for psychology, since with respect to other professional groups there is no reason why their professional locutions should provide an adequate account of human behavior. But if, as is here taken to be unquestioned, it is the central task of psychology to give an adequate account of human behavior, then this consideration, which is elsewhere <u>merely</u> a general methodological point, is for scientific psychology a crucial substantive point which provides a criterion for the adequacy of our scientific conceptualizations.

Evidently, the evolution of a scientific discipline is generally associated with a "streamlining" of the body of professional locutions which are required of the participants (this trend may be obscured by the extension of the discipline to new content areas, which generates additional terminology). The body of professional

locutions is likely to become more and more abbreviated and elliptical (i.e. 'parsimonious') to the extent that specialized training and standardized procedures facilitate cooperative activities among the participants. (Consider that many games may be played without anyone saying _anything_.) We might imagine, for example, that the actual operation of a psychological research center was carried out with no more communicative activity than an occasional nod or grunt. Participants in such a setting would not _need_ to refer to anything whatever. However, that would not render any simpler the task of providing an adequate description of what they were doing, and so it would not render any simpler the task of providing an adequate account of human behavior, and so it would not simplify the task of scientific psychology.

2. _Neatness._

The point of formulating the transition rules explicitly is that they codify behavior (these are transitions that _persons_ make), not that they put us into contact with states of affairs which are antecedent to human behavior and independent of it. The transition rules codify _our_ ability to move from one kind of description to another, but in this there is no implication that the reason we can do this is that there _are_ phenomenon of the sort we describe. (Neither is there any basis for denying that there is anything of the sort - there is no basis for saying _anything_ about _what_ is "out there." But then, we do not need to, either.)

If we give up the notion that the reason we are able to treat things as objects, processes, events, and states of affairs is

simply that there are such things, we will be less inclined to suppose that every transition that might be made in accordance with those rules in particular cases would be successful or intelligible or have a point. That is, we would not suppose a priori that every such move to a new kind of locution would be a case of describing something or referring to something or saying something. (No more than there is always a point to uttering the words, "I now pronounce you man and wife.") Indeed, as the limiting cases show, what we sometimes do is to refuse to make any further moves of a given kind, or conversely, to talk as though all the moves of a certain kind had already been made.

Thus, our ability to observe some objects, processes, events, and states of affairs and to move from a particular description of one kind to a corresponding description of the other kinds should provide no encouragement to adopt that familiar metaphysical proposition that all the states of affairs which we can describe are analyzable into statements about a single set of ultimate constituents, i.e., spatio-temporal statements about physical particles.

3. Referent and "Referent."

The notion of a "referent" as that item in the world to which a locution refers is a way of bringing some pragmatic constraints to bear on the elaboration of semantic apparatus. For example, it reminds us that to have six names or descriptions of a single piece of wood is different from having six descriptions, one each, for six pieces of wood. It reminds us, too, that when we invent

or apply six different descriptions to the same piece of wood we do not thereby create six pieces of wood.

In a semantic context, the "referent" has, in this way, a kind of absolute character -- referents are a limiting feature of a language, not a part of it -- referents are what our language is <u>about</u>, and they provide the "reality constraints" for our language.

In a pragmatic context (i.e., one in which nothing is excluded) there is no place for an absolute of quite this kind. Unfortunately, it is easy to carry over into pragmatic contexts those ways of talking which have found some use in semantic contexts, and which suggest such an absolute. Consider, for example, the following classic semantic formulations:

(a) "The map is not the territory."

(b) "The sentence 'snow is white' is true if and only if snow is white."

Both formulations, because they appear to imply that the distinction between language and reality is itself a pre-linguistic distinction (i.e., that the distinction can be known and has a basis completely independently of language) could be taken literally only if we were in a position to make those distinctions without language that we in fact make with language and only if we could without language take the world to exhibit (or consist of) just those states of affairs which we do take it to exhibit and which we <u>in fact</u> require our language in order to distinguish from those states of affairs which we take it not to exhibit.

With respect to the less complex version, (a) we should have to ask, "*What* territory is it that the map is not?" The answer to such a question cannot be given by pointing (NB the discussion in "Persons," Introduction, of the problem of identifying a subject matter) but only by saying (or an equivalent -- e.g., pointing will succeed only if there is an equivalent saying). But that is no less a "map" than the original "map" against which we were warned.

With respect to the second form, (b) since the locution "snow is white" is used as well as mentioned in that "metalinguistic" sentence, it seems clear that (b) presupposes that a certain state of affairs can be distinguished from others and can be taken to be the case. *Which* state of affairs is this? The state of affairs identified by the locution "snow is white." Without language we could not distinguish any state of affairs as being *this* state of affairs nor could we intelligibly take some other state of affairs to be "the same" as this one or "different" from this one. Thus, the determination that that state of affairs (snow being white) is the case is no less essentially the exercise of a linguistic competence than it is of a non-linguistic (e.g., visual observational) competence.

In a pragmatic context this is the general case with respect to referents. The determination of the referent of locution A is the exercise of linguistic competence with respect to some other locution, B. It is this feature of the situation which drops out of sight in the corresponding semantic context and

thereby gives the latter the appearance of coordinating something verbal with something non-verbal, for here the linguistic competence with respect to B is simply taken for granted as a feature of the "metalanguage" in which the "referent" is identified, but does not appear in the "object language" which contains the locution, "A," for which a referent is required. But in the paradigm case it is the same person who must exercise both the linguistic competence involving "A" and that involving "B." For this reason the separation of the two linguistic competences as belonging to two "languages" is likely to be more misleading than otherwise except possibly in certain technical semantic contexts. This is particularly evident when the same expression has to be regarded as two expressions (which suggests two competences) because they occur in different languages, i.e., the object language and the metalanguage. (Compare: "The referent of 'snow' is snow.")

The methodological error in much of our current and recent talk about "referents" or "denotation" is to suppose that being an object (or process, etc.) is a case of being a referent in the way that being a cat is a case of being an animal. The supposition is that objects, processes, etc. are what referents <u>are</u>. A less misleading formulation is to say that to refer to a particular object (or process, etc.) is <u>also</u> to identify a particular referent. (More briefly, an instance of "an object" is also an instance of "a referent.") And it is no more possible for a locution to refer merely to "an object" than it is for it

to refer merely to "a referent" or to "an instance." In all such cases we should have to know <u>which</u> object or <u>which</u> referent or instance. If we have not been told which, we have been told nothing. Without such knowledge, which in the paradigm case requires linguistic competence, we could at most identify a form of discourse or a domain of discourse but we could not have <u>said</u> anything substantive within that form or domain of discourse.

For example: Because we do (and can only) treat this "chair" in certain ways (and not others) with the ease and difficulty that we do and in the kind of circumstances we do, this chair is an instance of "an object"; because we talk about it in the ways that we do (which is indispensible to <u>those</u> being the ways we treat it and to their <u>being</u> the ways we treat it) this chair is an instance of "a referent"; and on both counts it is an instance of "an instance."

But to what do we refer by the "this," and what is the "it" that is an instance of "chair"? We have no way to answer such a 'question,' and so it is not a question. What we do have is the competence to say, on some occasions and not others, that what we have spoken of as <u>some</u> object in this way and as <u>some</u> object in that way are "the same" in the sense of being the same object (or that they are "different" in the sense of being different objects). If we can distinguish one "piece of wood" from another and one "chair" from another, than I can say that this piece of wood is what I am talking about when I say "my

chair." Here, one might be inclined to say that this piece of wood was the referent of "my chair,' that it was the "territory" of which "my chair" was merely a 'map.' But I might also say that <u>this</u> chair is the one I am talking about when I say "my chair," and now there will be no tendency to see a 'referent' here or to distinguish 'map' and 'territory.' And neither case requires an "it" which is known prior to an independently of <u>any description</u> (e.g., "piece of wood," "chair") and of which it is known that "it" instantiates just those descriptions (e.g., "piece of wood," "chair," "physical object") which it in fact does instantiate. (Classically, this point is put in the form: "We have no knowledge of bare particulars.")

Enlarging the scope of discussion from semantic to pragmatic provides significant new opportunities for recognizing two apparently different things as "the same." For it becomes clear that the notion of a prelinguistic access to reality (commonly formulated as the perception of physical objects) is "the same" as the apparently very different notion of a unique, <u>real</u> description of states of affairs (ordinarily conceived of as a physical-object description) by means of which we specify the referents of other forms of locution. Both represent the same attempt, i.e., the attempt to assert a <u>privileged</u> access to Reality, hence an attempt to deny the reality constraints codified by (not caused by) our use of language. In both cases the attempt is carried out by initiating a new way of talking, as though the reality constraints lay in the talking we engaged in rather than in the limitations on what we

can do at a given point in history, including the limitation of the mutual dependence of what we can say and what else we can do.

Ordinarily the thesis of a prelinguistic access to reality is defended by reference to the ability of human infants (preverbal) and speechless animals to discriminate among objects and behave accordingly. Their behavior, we say, cannot depend on language, for they have none, hence it is simply perverse to talk as though language created the behavior described in the language. But it is important to note that it is not simply the case that infants and animals discriminate among objects and treat them accordingly. An essential feature of the situation is that they discriminate the same objects we do (we could not know it if they distinguished other objects which we do not) and treat them in ways that we recognize as "treating them accordingly."

The statement that the referent can exist in the absence of the referring terminology appears to be based on the reification of the verbal "it" into an underlying, real IT, in contrast to its genuine function of coordinating among a class of referents which are "the same" object (or process, etc.). For if we do not have the picture of a real IT which corresponds to our verbal "it" (why should there be and how could anyone know it) we will not suffer the usual pangs at the idea of creating something, for that will amount only to doing something different, and that does not bother us at all. The proper model for "this pawn and this piece of wood are the same object" is "six plus two and eight are the same number."

It does not bother us, for example, to say that we created pawns when we invented the game of chess and also to say that this pawn may be the referent of some present locution, e.g., "this piece of wood" or "this physical object." We see nothing contradictory between saying both of these and saying that that piece of wood, which is "the same" object as that pawn, might have been there even if there were no such things as pawns; but then, it will also be the case that the pawn might have been there even if there had been no such thing as "a piece of wood" or "a physical object." And nor does the latter tempt us to say that that pawn might have been there even if there were no such thing as a pawn.

Yet we forget this logic when we say that this nonverbal infant grasps that pawn or that piece of wood or that object and that this in no way depends on there being people who know, and therefore talk, about pawns or pieces of wood or objects. The infant's grasping the pawn in no way depends on his knowing of pawns or speaking about pawns because it is not for him that we speak of his grasping that pawn. It is for us that we say this, and it is in our lives that his grasping that pawn has a place - that he grasps that pawn is an achievement which we describe, not yet a performance which he engages in. It is a fact for us, not for him. His "grasping that pawn" is part of our activity, but not yet his. To speak of his grasping that pawn is like speaking of the knight capturing that pawn. To think of this as something the knight does, independently of

ourselves who alone speak of it and know of it, takes on the appearance of a naive realism with respect to language (this being the consequence of taking a certain kind of linguistic competence for granted).

But what do we say to one another about the infant (what is the "factual reference") when we say that he grasps this pawn and distinguishes it from other objects, even though he does not know what a pawn is? Well, what do we say about that knight when we say that it captures that pawn? There is nothing in question in the latter case. We do not even feel the need of adding that the knight does not know what a pawn is, for nobody would have supposed that to begin with. In contrast, there will come a time when "the same" human object will no longer be an infant and will know of and speak of pawns, and so there is a point in denying that he has yet acquired that ability. There is also equal point in noting that what is going on is importantly similar to what would be going on later when he might straightforwardly grasp a pawn. And so we say, "he grasps that pawn" but "he doesn't know that that is what he is doing." There is a point to our saying that.

The pragmatic formulation of language leads us to ask, not the semantic question, "What is the reality that would make that statement true?", but rather, the pragmatic question "What is he doing in saying that?" or, alternatively, "What is the point of his saying that?" And the point of this

transition is to bring us from the verbal fantasy of an ideal, unknowable realm of Truth to a knowable and often manageable reality. Whatever hinges on its being a pawn that the infant grasps (and not, e.g., merely a piece of wood or something else) can be a contingency only for individuals who know of pawns and speak of them, and distinguish them from pieces of wood and other things, i.e., us.

We want to say, "But the contingencies, the consequences, of his grasping the pawn are natural events. They don't depend on what we call them - what we say doesn't create facts or events out there." To be sure, what we say doesn't create the facts or events we talk about. But that fact is a linguistic fact.

It is as though we said, "The numbers we add or multiply do not create or cause sums or products." There is no question about this, either, nor do we have to establish this empirically. Neither, however, is there any question that we could have no sums or products if we had no numbers. The phenomena of sums and products would be non-existent except for the following conditions:

(a) We dintinguish one number from another.

(b) We know how to multiply or add numbers.

(c) When we add the result is a sum, and when we multiply the result is a product.

(d) We distinguish one sum or product from another.

(e) _Which_ sum results is determined by _which_ numbers were added, and _which_ product results is determined by _which_ numbers were multiplied.

That _this_ sum is the sum of _these_ numbers is not a fact by virtue of my saying so. Rather, it is a consequence of _our_ having a way of establishing it (we calculate). And our having this way of establishing it is _wholly_ dependent on the numerical distinctions we make. That we make the distinctions we do (and no others) is as "hard" a fact as the hardest fact imaginable, and so the conclusion that some other facts depend on this fact, though they are not equivalent to the latter, is in no sense a falling away from objectivity.

Similarly, it is only because we distinguish the different events (and objects, processes, and states of affairs) that we do that there is any such thing as a cause, contingency, or consequence. For it is only because we make the _particular_ distinctions that we do (and that requires language) that a _particular_ event or state of affairs stands in a causal relation to another particular event or state of affairs. Were it not for particular events standing in causal relationships there would be no such phenomenon as "causal relationship" - there would be no such application of this locution as it now has, and so the question of a "referent" for it would not even arise (_Not_ "would not arise for us," but simply "would not arise"). That a given antecedent is _that_ antecedent rather than some other one, and that what its consequence is is _this_ consequence rather than some other one, depends _wholly_ on

the fact that we can and do make the distinctions we do (including the distinction between antecedent and consequent), that we can and do say what we do, and that we know how to treat something as an event and as a consequent or antecedent. ("Consequent" and "antecedent" identify a relationship between event constituents or state-of-affairs constituents of a state of affairs - see "d" under "Characteristic Features," above.)

We have heard it said, as a part of our semantic mythology, "An experiment is a question posed to Nature, and Nature provides the answer." But, of course, it is we who provide the answer. That is a consequence of our having a way of arriving at an answer (a different sort of "calculation"). That we have a way of arriving at an answer is not itself an empirical discovery.

That we can and do say and distinguish and do as we do is different from our being unable to do these things, and we can say this as a linguistic fact even though we cannot say what it would be like if we were unable to do the things we do. (It is like being able to say, and say sensibly, that our playing chess and bridge and no other games is different from our playing other, unknown games instead, even though we cannot say what it would be like to be playing some other, unknown game instead.) That we can and do distinguish and do as we do and not some other way or not at all is the state of affairs in which we find ourselves - it is "reality." Since our present ability to do this range of things and not some other is the same as our present inability to do some other range of things, we may say that our present range

reflects "reality constraints." Although our saying so may appear unexciting because it refers to a linguistic fact (for we sometimes forget that language is part of reality, too), it is a way of doing justice to the facts of our limitations in a nonparadoxical way. Unlike most attempts to give an account of human limitations, it does not require the self-contradictory supposition that we somehow have knowledge of something that could not be known (Reality, independently of human activities) or that we somehow have the ability to do something that could not be done (discover that Reality).

Section III. Expansion of II_6 of Outline

Thoughts and Thinking

"I have a penny in my pocket." That tells us about a person, something about his resources and circumstances.

"I have a penny in the bank." That tells us something about a person's resources and circumstances, too, but now this is not accomplished by telling us about a round object and a place. I know how to look for the penny in his pocket, and I know what it would be like to find it. In the other case, I do not have to suppose that there is a similar object at the bank, and if I were there, I should not know what object to ... for.

People have thoughts. But having a thought in my head is not like having a penny in my pocket. It is not that kind of having. Rather, it is much more like having a penny in the bank. The fact that we <u>have</u> thoughts reflects the fact that thinking is something we all <u>do</u>. (If there were no such social practice as the spending of money, there could be no such resource as money and no such circumstance as my <u>having</u> money, either.) To say this about people is to say something about their knowledge, skills, abilities, performances, and achievements, as well as the social practices in which they participate. It is not to say something about a hidden computing process that results in, precedes, or governs their behavior.

Saying this, of course, does not make the job of understanding thought and/or "implicit behavior" any easier except insofar as it may reduce the likelihood of pursuing dead ends in our investigations or in our conceptualizations. It is still the case that a person's having this thought rather

than that one (or, indeed, his having any thought at all at a given time) is frequently difficult to establish in any practical sense and is impossible to establish beyond any possible doubt, and so speculation is easy, dissimulation is feasible, and confusion is common.

One thing that can be said with confidence is that for an individual to have a thought is for an event to have occurred. Such events are datable and locatable. They occur at a particular time and to a particular individual.

An event is, per se, a change in something. Then what is it that undergoes a change when a thought occurs? The person to whom it occurs, of course. But can something more be said about the difference in his state that constitutes his having had the thought?

Several answers might be given. For example, the difference might be that he has a certain amount of mental (or verbal, if that be different) imagery; or it might be a change of a physiological sort, for one is at no time without such changes; or it might be a new disposition to behave in identifiable ways. But none of these changes is a logically necessary condition, and none have been shown to be empirically sufficient conditions for thinking a particular thought. That is, when any of these sorts of changes do occur, it is not their occurrence that makes the thought the thought it is or guarantees the occurrence of any thought at all. [The presence of a penny at the bank is not a guarantee of anything at all, either.]

There is only one answer that seems adequate, in principle, to cover all the cases that we know. That is, when an individual thinks of X or has the thought of X, what has changed is that he is now in a better

position to exercise particular skills in particular ways corresponding to particular achievements. In brief, having a particular thought represents a change in the individual's possibilities for behaving.

To illustrate: If I think of a solution, or a possible solution, to a problem, my relation to a part of the world has changed. I can now perform in certain ways, i.e., solve the problem, or at least, attempt to do so, which before I could not. To be more concrete, if it occurs to me (if I have the thought that) the combination to that safe is given by the numbers I saw written down on the paper lying on the table (i.e., the numbers 32-13-62), then I am in a position to open the safe straight away (if I am right), or at least, to make <u>that</u> attempt rather than some other, because it was <u>that</u> thought rather than some other.

Having a certain thought is an event which is a change of state The resulting state is a position from which (a condition in which) the individual might better undertake certain actions rather than others. When one of the facilited actions does occur (for example, if I do go ahead and open the safe, using the combination 32-13-62), it is natural to think of the thought as part of that behavior, even though we have to qualify it as an invisible, initial part. It is easy to do that because having had the thought explains, or helps to explain, the occurrence of that behavior. We say, "He did X <u>because</u> it occurred to him that P." If we take it for granted that an explanation must refer to a cause, we may use, "It occurred to him that P," as a way of identifying that hypothetical cause.

When the facilitated behavior fails to occur (e.g., when the thought leads, instead, to another thought) we do not need to suppose that anyway,

the invisible part (the thought) has occurred. When we report (of ourselves) or suspect (of others) the occurrence of a particular thought what we report or suspect is basically just the fact of having come to be in a better position to do such and such. Only sometimes is any inclination or preparation to do such and such involved. That I was in a better position to do such and such at a given time is part of the significance of what I did at that time. This is so whether I say that I did X because it occurred to me that P, or that I didn't do Y because it occurred to me that P, or that I did Q in spite of realizing that P, or that I didn't do R earlier because it hadn't yet occurred to me that P, etc., etc. Whether or not the thought was one that was acted on, reporting the thought clarifies what behavior it was that took place then or subsequently.

In telling a story, I do not describe the story--I tell it. And in telling what I thought, I am not describing my thought--I am telling it.

"I went out to the terrace because it occurred to me that he might be there." In telling my thoughts I am telling something about my resources and circumstances. I am presenting myself in a certain light, not by describing what went on inside, but by identifying what I had to go on. I am thereby clarifying what behavior it was that I engaged in. Thus, although I am not giving a description of any sort, I am endorsing a certain description of what behavior it was that I engaged in (in the present example, the description is that I was searching for him).

It is one thing to explain what I did by reference to a certain thought that I had. It is another to say no more than that I had a certain thought. One point of distinguishing between the inclination to act in a

certain way and having such and such a thought is to take account of the fact that the report of having such and such a thought is noncommittal in just the way that the report of having a certain object is noncommittal (which may help to make clear why it makes sense to talk in such similar ways about having a penny and having a thought). That is, we can give no exhaustive list either of what might be done with that object or of what might be done on the basis of having that thought. (And if we had such a list, we could have no way of discovering that it was exhaustive.)

In the example given, I might have opened the safe, but equally, I might have asked someone whether that was the combination, or I might have wondered why it should be in plain sight, and so forth. Whatever it is that we identify when we speak of "the thought of X," it is not something from which the occurrence of a particular behavior follows, and so a thought does not have the characteristics of something which produces specific behaviors in the manner suggested by reference to hidden, underlying computing processes.

If having a thought is an event, why isn't thinking a process, a mental process buried away in deep structure of behavior. Isn't this what we are talking about when we speak of pondering, reflecting, calculating, deliberating, etc., in everyday discourse? Of course we are speaking of the deep structure of behavior here. And we ought to ask, how could the deep structure of a behavior consist of an intangible, non-behavioral something (or worse, a tangible something) which produced the behavior? Equally, how could it possibly consist of the invisible beginning of that behavior? No, the "deep structure" of a piece of behavior consists of its being precisely the particular behavior that it is, and as such, importantly

different from some other behavior. Its having a "deep structure" at all reflects the further fact that what behavior it is is frequently not obvious and that to identify what behavior it is may require reference to objects and events not then and there observable or to circumstances the recognition of which requires a high degree of skill.

We may see behavior as a simple thing, and then thinking will be a complex function of behavior. [That complex function might be formulated as a complex antecedent, if we insisted on talking in a causal idiom, but then it would have to be an invisible, intangible antecedent rather than an empirically ascertainable, observable antecedent.] In contrast, we may see behavior as complex, and then thinking will be a relatively simple aspect of it. The latter formulation perpetuates no mysteries.

What, then, about the "process" characteristics of pondering, reflecting, deliberating, calculating, etc.? These are what we might describe an individual as doing at a given time and for a certain period of time, and this is characteristic of processes rather than events. However, a little reflection will show that these are activity descriptions rather than process descriptions [or better, that the process in question is a behavioral process, i.e., an activity, not an internal process]. To say that a person is "pondering," "reflecting," and so forth is like saying that he is "drawing" when in fact he is drawing a picture of a horse [or like saying that something is "colored" when in fact it is blue]. That is, it is an incomplete, or non-committal description. A person cannot merely ponder, he must ponder about something. And he cannot ponder about something without having certain thoughts which are systematically related. It is the particular thoughts he has which determine what he is pondering

about, and it is his having those thoughts during that period of time that constitutes his having pondered during that period of time. But having those thoughts was a series of events, not a process. The activity of pondering is what he was engaged in during the time he had those thoughts. Thus, "pondering" is not the name of a distinctive, inner process which brought about those thoughts. We know of nothing relevant that was going on in between his having those thoughts and that brought them to pass, even though the superficial structure of our references to "pondering" et cetera suggest that we do.

This is the case for underlying psychological processes generally -- for example, "making a decision," "adding two numbers," "selecting a hypothesis," "testing a hypothesis," or "forming an association." Even though we casually speak of the "process" of making a decision, forming an association, selecting a hypothesis, etc., the cash value of this kind of talk is brought out quickly by asking some simple test questions such as "What is it like to be part way through the process (of adding, selecting a hypothesis, forming an association, etc.), and what would be the result if the process stopped part way through?" When we do this, we discover that there is no difference between a process of this sort having failed to come to completion and its never having begun. In this important respect, psychological processes are quite different from the familiar paradigm cases of water flowing down a slope or an object moving from one place to another, and in the same way they are quite different from the invisible processes of the transfer of heat or electric charge from one body to another. To recognize these differences is to see that our apparent references to invisible processes of a psychological kind are

better described as disguised references to events of a psychological kind. What we do observe or discover is that a decision was made, a hypothesis was selected, an association was formed, etc., and these are events. It is not a matter of lacking information or being technically limited in our means of observing the processes which produce those events, but simply, of not knowing of anything to be looked for. Nothing that we know how to look for or recognize would qualify as such a process. Thus, to speak of such processes is not like spreading the rumor that, contrary to what we commonly believe, strange goings-on are constantly taking place in people's heads. Such a rumor might be shown to be well grounded, or else to be baseless, and it would make a difference which of these conclusions we arrived at. Whereas, underlying processes can as little be <u>shown</u> not to exist as they can be shown to exist. Because of this, there is no difference between there being such processes and there not being such processes. And so, also, there is no difference between our talking <u>about those processes</u> in the way that we do and our merely talking <u>in a peculiar way</u>.

So what is missing in an account of behavior or thinking which fails to mention any underlying processes? To be sure, there are observable physiological processes which occur and recur (and, hopefully, can be related empirically to behavior and thinking). And unquestionably there are observable psychological processes, i.e., overt behavior, the structure and course of which we frequently describe in terms of "thinking" or of having particular "thoughts." Is anything missing here? Are there any real questions about thinking or behavior the answer to which depends on the discovery of a hidden, inner process? Questions exist only when we

can recognize an answer as the right answer and when something hinges on what the answer is. References to underlying processes evidently fail on both counts. But we can, it seems, give answers to questions about thinking and behavior by reference to learning, experience, abilities, performances, and achievements.

APPENDIX R

Computer Simulation of Observational Judgment of Persons

by

Thomas O. Mitchell

Research paper submitted to
Department of Psychology
University of Colorado

Computer Simulation of Observational Judgment of Persons

by

Thomas O. Mitchell

This study concerns the computer simulation of persons who 1) observe other persons and 2) make judgments about the persons whom they observe. The purpose of this study is an initial exploration of the feasibility of such a simulation. The parameters for the simulation have been derived from Ossorio's (1966) description of the concept of Persons.

Observational Judgment

One's behavior towards a person, whether himself or another, is guided by his understanding of that person. This understanding involves judgments, based on observation, of 1) the actions that the person performs and 2) what kind of person he is. The better such judgments are made, the more likely is behavior toward the person judged to be appropriate (other things being equal). For example, one who cannot distinguish between a friendly slap on the back and an angry blow might not respond appropriately to either. Similarly, if one cannot distinguish between persons who are characteristically hostile and persons who sometimes have angry moods, one's behavior in hostility-provoking situations is unlikely to be reliably appropriate.

Actions

Intentional actions are distinguished and classified by reference to four structural concept-types or logical parameters (Ossorio, 1966): 1) Performance--an overt attempt to achieve some goal; 2) Want--reason

for acting, desire, motivation; 3) Know How--skill or ability; 4) Know --knowledge, understanding, belief, perception.

In the example above of a slap on the back, one might distinguish between a friendly slap on the back and a hostile blow by reference to the logical parameters of action. 1) Performance: was the slap harder than the usual friendly gesture? 2) Know: did the one who slapped know that the other person was suffering a third-degree sunburn? 3) Know How: was the person who slapped a habitual back-slapper, whose repertoire of friendly overtures consisted primarily of slapping others on the back? 4) Want: is there some reason to think that the person who slapped wanted to hurt the other person?

Individual Differences

Among the individual difference concepts discussed by Ossorio (1966; 1967) are traits, attitudes, moods, needs, states, abilities, and interests. In applying these individual difference descriptions, series of intentional actions of the same type are distinguished from other such series by criteria such as frequency and intensity. Thus, to say that a person has a certain trait is to say that he has a disposition to engage in certain kinds of intentional actions with unusual intensity or frequency. If we say that a person is hostile, we understand him to be the kind of person who acts unfriendly more often, or with less provocation, than the ordinary person. Again, to say that a person has an attitude, e.g., of hostility towards Negroes, is to say that he has the disposition to perform certain kinds of intentional actions, viz., unfriendly ones, with unusual frequency or intensity towards a specific class of objects, viz., Negroes.

Individual difference descriptions such as these indicate the differences between persons which make appropriate different expectations of their behavior and different ways of reacting to them. In the example above of distinguishing between a person who is in an angry mood and a person who has the trait of hostility, one might postpone dealing with irritating topics if the person is simply in an angry mood, but might have to confront such issues directly if the other person has the trait of hostility.

Method

The method employed in this study is the simulation by computer of observational judgment. The primary concern here is with the method itself: the goal of the study is to achieve a reasonably successful simulation and to get some idea of the further steps which might be involved in refining this method. If this method proves feasible, it should be applicable to the substantive problems of observational judgment. That is, if observational judgments can be successfully simulated, one should be able to compare successful and unsuccessful observers, i.e., persons whose behavior towards persons they observe is appropriate or not appropriate. The inadequacies and inconsistencies of unsuccessful observers might be specified and, perhaps, some indication given of how to improve their judgments.

Simulation

Simulation, as used here, means an operating representation of the central features of some phenomenon (cf. Guetzkow, 1963, p. 25). This representation might be a physical model, e.g., a wind tunnel, or it might be symbolic, e.g., a computer program. It must, however, be an

"operating" representation; that is, the representation must reproduce some change from one state of affairs to another in that which is simulated. The manner in which the simulator and the simuland must corresp is not specified. A simulation, in this sense of the term, might represent either 1) the final state of affairs, given the initial state of affairs--an outcome simulation; or 2) the process by which the change is achieved as well as the final state of affairs--an achievement simulatio

Simulable aspects of observational judgment

Three aspects of observational judgment might be distinguished: 1) the perception by an observer of another person's overt behavior; 2) the assessment by the observer of a) what action was observed and b) the kind of person who performed the action; and 3) the performance by the observer of some action toward the person he has observed.

The first aspect, information input, is not simulated in the present study; categorizations by the observer of observed behavior are input to the computer. This division of function between computer and person-observer might be unnecessary at some future time; it seems that the computer can, in principle, perform the functions of information input as in, e.g., pattern recognition.

The second aspect, assessment, is principally focused here on the action performed. The skills and motivations of the person who is observed to act are assessed in the light of 1) the performance he exhibited and 2) what most people want and know how to do in similar situations. Comparisons of individual differences are not made explicitly, nor are the persons observed described explicitly in terms of traits, attitudes, moods, or other individual difference concepts.

The third aspect, performance, is limited in this simulation to the prediction by the observer of what the one observed is likely to do in a specified future situation.

In summary, the simulation of observational judgment described here involves programming a computer to 1) accept information from the observer concerning a) the parameters of intentional action and b) the performance observed, and 2) to combine this information so as to achieve the same outcome as the observer, i.e., to predict the performance of the person observed. This simulation is therefore an outcome simulation; given an initial state of affairs, viz., the observation of a situation, the simulator reproduces the final state of affairs, viz., the prediction of future behavior.

Procedures

There were four steps in the simulation: 1) an observer, A, made baseline judgments on the parameters of intentional action; 2) one person, B, reacted to another person, C, in a hostility-provoking situation; 3) A observed the interaction and predicted the reaction of B to C in future, similar situations; 4) the computer combined the baseline information in a way which duplicated as closely as possible A's predictions of B's future behavior.

Subjects

As. There were four observers, As: A1 was the experimenter; A2 was a paid female graduate student in Russian literature; A3 was a paid male graduate student in Business; A4 was a pseudo-observer, for which pseudo-random data were generated by computer.

The two paid As received $1.50 per hour. Each paid A worked a total of 20 hours, completing the task in one week by working three to four hours per day.

Bs. The Bs were 10 undergraduate students in introductory psychology courses. They worked two hours and received class credit for their participation in the experiment.

Cs. The Cs were hypothetical persons whose behaviors toward B were described in written statements.

Parameters of intentional action

Three parameters were varied: 1) Want; 2) Know How; and 3) Performance. The Know parameter was held constant; it was presumed that most observers would judge most persons to perceive the situations to be hostility-provoking.

The Want and Performance parameters were exemplified by categories specified by the experimenter. The specific examples were chosen on the basis of a conceptual analysis, by the experimenter, of the average person's reactions to hostility-provoking situations. The lists of specific wants and performances were exhaustive by virtue of categories such as "other hostile want" and "other non-hostile want."

Specific performances

1. Hit, push, kick C.
2. Use weapon against C.
3. Insult C.
4. Threaten C.
5. Tell C to stop.
6. Tell third party of feelings.

7. Ask third party for help.

8. Refuse to speak to C.

9. Give C a dirty look.

10. Leave situation.

11. Other hostile performance.

12. Ignore C and C's actions.

13. Let C know you're not angry.

14. Divert C's anger to a different target.

15. Show C's behavior is unnecessary.

16. Go along with C's behavior.

17. Other non-hostile performance.

<u>Specific wants</u>

The first 17 wants were the 17 performances, above, considered as ends in themselves. There were also the following specific wants:

18. Harm C physically.

19. Harm C emotionally.

20. Harm C socially.

21. Harm C financially.

22. Prevent C from doing the same thing again.

23. Prevent C from attaining his goals.

24. Undo the effect of C's actions.

25. Restore own status.

26. Remove C from the situation.

27. Refuse to associate with C.

28. Make known feelings.

29. Destroy C.

30. Other hostile want.

31. Help C obtain goals.

32. Encourage C.

33. Make C happy.

34. Get other people to like C.

35. Let C do the same thing again.

36. Associate more with C.

37. Other want incompatible with hostility.

38. Achieve own original goal.

39. Other non-hostile want.

<u>Baseline judgments</u>

A rated the examples on numerical scales. The examples of the Want parameter were rated on 1) a 20 point scale of intensity of want and 2) a 20 point scale of intensity of constraint against want, i.e., strength of wanting not to want, whether on moral or prudential grounds. The examples of the performance parameter were rated on 1) a 20 point scale of likelihood that performance would be observed and 2) a 10 point scale of the suitability of performance as a means to each want as an end.

There were two kinds of ratings for specific performances and specific wants: 1) ratings of likelihood or intensity in hostility-provoking situations in general; 2) ratings of likelihood or intensity in the 15 specific hostility-provoking situations used in this study. There was one kind of rating for constraint and for suitability, viz., a rating of constraint intensity or suitability in hostility-provoking situations in general.

A made objective ratings rather than subjective ratings or value judgments; e.g., he rated each want on how strongly he thought most people would feel that want, not on how strongly he would feel the want himself or how strongly he thought one should feel the want.

Hostility-provoking situations

B read the description of the situation and of what C had done to him and stated his hypothetical reaction to C's behavior in an open-ended answer to the question, "What would you really do?"

There were 15 hostility-provoking situations:

1. You are standing in a movie-ticket line when someone your own age and sex breaks into it in front of you.

2. After getting back an examination you find that it has been scored incorrectly. The instructor refuses to look at the paper.

3. You are sitting at a desk working intently and someone gives you a hard slap on the back, startling you.

4. Someone borrows a book of yours and then denies having it.

5. The "hot" soup you ordered in a restaurant is served cold.

6. You are about to back into a parking place when someone pulls into it behind you.

7. An acquaintance makes an appointment to see you and fails to show up.

8. You see a child bullying a smaller child.

9. One member of one of your classes dominates the discussion and monopolizes class time with trivia.

10. You are studying intently in the library when some persons at your table begin talking.

11. You see someone throw garbage on the ground when a litter basket is available.

12. You see someone sitting on the fender of your car.

13. You are in a group discussion and someone calls your remarks stupid.

14. You are driving and in a hurry to get to an important meeting or appointment and you have to stop at an intersection. The light changes to green but a pedestrian is crossing in front of you. The person is walking extremely slowly and is holding you up.

15. You are talking to some friends when a stranger hits you in the head with a snowball.

Each of the actions of C was predetermined and independent of B's response to the previous action. Thus, each B responded to the same action by a C at the same point in the series of hostility-provoking situations.

<u>A's observation of the situations</u>

In each of the hostility-provoking situations, A: 1) observed C's actions; 2) ranked the specific performances in order of the likelihood that each would be B's reaction to C's action; 3) observed B's reported response to C's action and specified the performance which, in his judgment, best described B's behavior.

<u>Computation</u>

The computer was programmed to: 1) rank specific performances in order of likelihood of occurence; 2) receive A's categorization of B's behavior; 3) compare its own prediction with A's observation and revise its assessment of B's wants and skills on the basis of the A's description of B's reported reaction to C.

Estimation Rules

The predictive and corrective functions employed in the computation were specified by Estimation Rules. Several Estimation Rules were tested. The two most successful, Maximum Want Rule and Total Want Rule, are described here.

Definition of terms

Let

i be the subscript designating a performance;

j be the subscript designating a want;

k be the subscript designating a situation;

c_{jk} be the current estimate during situation k of constraint against want j;

p_{ik} be the current estimate during situation k of general likelihood of performance i in any hostility-provoking situation;

p^*_{ik} be the specific likelihood of performance i in situation k;

$\hat{P}_{ik}$ be the total likelihood of performance i in a specific situation k;

S_{ij} be the suitability of performance i as a means for achieving want j;

w_{jk} be the current estimate during situation k of general intensity of want j in any hostility-provoking situation;

w^*_{jk} be the specific intensity of want j in situation k;

$\hat{W}_{jk}$ be the total intensity of want j in some specified situation k.

Further, let

v be the subscript of the observed performance;

$Q(W,m)$ be the function of the set of wants, W, and set of integer numbers, m, such that the value of the function is the subscript of the want which ranks m in order of total intensity ($\hat{W}$).

$T(P,m)$ be the function of the set of performances, P, and the set of integer numbers, m, such that the value of the function is the subscript of the performance which ranks m in order of total likelihood ($\hat{P}$).

$L(W,v,m)$ be the function of the set of wants, W, the observed performance, v, and the set of integer numbers, m, such that the value of the function is the subscript of the want which ranks m in order of suitability for achievement by the observed performance, v.

I. Maximum Want Rule

A. Prediction:

In each situation k, define

$$\hat{W}_{jk} = \frac{w_{jk} + w^*_{jk}}{2} - c_{jk} , \tag{1}$$

where $w_{jk} = w'_{jk-1}$ and $c_{jk} = c'_{jk-1}$

(see equations (11) and (12)).

Then, define

$$\left.\begin{aligned} q &= Q(W,1) \\ \hat{P}_{ik} &= S_{iq}\left(\frac{p_{ik} + p^{*}_{ik}}{2} - c_{ik}\right) \end{aligned}\right\} \qquad (2)$$

B. <u>Comparison of observed and predicted performance</u>

Let

$$t = T(P,1) \qquad (3)$$

Then,

if $t = v$, go to situation $k + 1$;

if $t \neq v$, go to step C.

C. <u>Correction of want and constraint intensities</u>

Let

$$\left.\begin{aligned} a &= L(W,v,\ 1) \\ b &= Q(W,1) \\ c &= Q(W,2) \end{aligned}\right\} \qquad (4)$$

Then, define

$$D = \frac{\hat{W}_{bk} - \hat{W}_{ak}}{2} \qquad (5)$$

$$E = \frac{\hat{W}_{bk} - \hat{W}_{ck}}{2} \qquad (6)$$

and define

$$w'_{ak} = w_{ak} + D \qquad (7)$$

$$w'_{bk} = w_{bk} - E \qquad (8)$$

$$c'_{ak} = c_{ak} - D \tag{9}$$

$$c'_{bk} = c_{bk} + E \tag{10}$$

Then, standardize the want and constraint intensities

$$w'_{jk} = \frac{s_w}{s_{w'}} \left\{ w'_{jk} - (\bar{w} - \bar{w}') \right\} \tag{11}$$

$$c'_{jk} = \frac{s_c}{s_{c'}} \left\{ c'_{jk} - (\bar{c} - \bar{c}') \right\} \tag{12}$$

where $\bar{w}$ is the mean, and s_w is the standard deviation, of w, the uncorrected general want intensities; $\bar{w}'$ is the mean, and $s_{w'}$ is the standard deviation, of w', the corrected general want intensities; etc.

D. Correction of performance likelihoods

Remembering that

$t = T(P,1)$

v = subscript of the observed performance

let

$$u = T(P,2) \tag{13}$$

Define

$$F = \frac{\hat{P}_{tk} - \hat{P}_{vk}}{2} \tag{14}$$

$$G = \frac{\hat{P}_{tk} - \hat{P}_{uk}}{2} \tag{15}$$

and

$$p'_{vk} = p_{vk} + F \tag{16}$$

$$p'_{tk} = p_{tk} - G \tag{17}$$

$$c'_{vk} = c_{vk} - F \tag{18}$$

$$c'_{tk} = c_{tk} + G \tag{19}$$

Then, standardize

$$p'_{ik} = \frac{s_p}{s_{p'}} \left\{ p'_{ik} - (\bar{p} - \bar{p}') \right\} \tag{20}$$

$$c'_{ik} = \frac{s_c}{s_{c'}} \left\{ c'_{ik} - (\bar{c} - \bar{c}') \right\} \tag{21}$$

where $\bar{p}$ is the mean, and s_p is the standard deviation, of p, the uncorrected performance likelihoods, and $\bar{p}'$ is the mean, and $s_{p'}$ is the standard deviation, of p', the corrected performance likelihoods, etc.

II. Total Want Rule

A. Prediction

Define $\hat{U}_{jk}$ as in equation (1). Then, define

$$\varsigma = Q(W,m)$$

$$\hat{F}_{ik} = \sum_{m=1}^{\hat{U}_{qk} \leq 0} \frac{1}{m} \left(\frac{p_{ik} + p^*_{ik}}{2} - c_{ik} \right) \tag{22}$$

B. Comparison of observed and predicted performance

The comparison is the same as in step B of the Maximum War Rule: let $t = T(P,1)$ as in equation (3); then, if $t = v$, go t situation $k + 1$, if $t \neq v$, go to step C.

C. Correction of want and constraint intensities

Let

$$\left.\begin{aligned} a &= L(W,v,m) \\ b &= Q(W,m) \\ c &= Q(W,m-1) \end{aligned}\right\} \qquad (23$$

Then apply equations (5) through (12), followed by steps .. and D of the Total Want Rule. Begin with $m = 1$ and increase m by one each time equations (5) through (12) are repeated, unti $t = v$ in step B.

Results

The analysis of results concerned: 1) similarity of As' baseline judgments; 2) goodness of simulation; 3) discriminant simulation; and 4) differences between simulations associated with differences in Estimation Rules.

Insert Table 1 about here

Similarity of baseline judgments

The product-moment correlations between baseline judgments over al categories and all situations are given in Table 1. There is substant correlation between ratings by the three genuine As (range from .56 t

	A1	A2	A3	A4
A1		.63	.61	.05
A2			.56	.10
A3				.07
A4				

Table 1. Product-moment correlations between As' baseline judgments over all parameters and all situations. (N = 1875)

		I				II							
						A1		A2		A3		A4	
		A1	A2	A3	A4	Max	Tot	Max	Tot	Max	Tot	Max	Tot
A1			.55	.47	.01	.49	.50	.36	.21	.30	.31	-.01	.03
A2				.54	.00	.49	.44	.40	.40	.29	.25	-.03	-.04
A3					-.00	.31	.26	.21	.09	.42	.38	-.06	-.10
A4						.02	-.02	.04	.03	.02	.01	.04	.01
A1	Max						.77	.59	.45	.45	.39	.03	.01
	Tot							.54	.44	.37	.44	-.02	.04
A2	Max								.64	.27	.24	.14	.17
	Tot									.08	.06	.14	.12
A3	Max					III						.00	-.09
	Tot											-.04	-.13
A4	Max												.61
	Tot												

Table 2. Product-moment correlations between rankings of likelihood of performance over 10 Bs in all 15 situations. As' ratings indicated by A1, A2, A3, A4. Simulated rankings indicated according to Estimation Rule: e.g., A1 simulated according to Maximum Want Rule indicated by A1 Max, A1 simulated according to Total Want Rule indicated by A1 Tot, etc. (N = 2550)

.63). The baseline judgments of A2 correlate significantly less with the judgments of A3 than do the judgments of A1 correlate with either A2 or A3 ($p < .0001$, by test for significance of difference between correlated correlations (McNemar, 1962, p. 140)).

The correlations of A2's and A3's baseline judgments with the random judgments of pseudo-A, A4, are significantly different from zero, although small (with 1878 observations, $r = .06$ is significantly different from zero, $p < .01$, two-tailed). This correlation may indicate some hitherto unsuspected regularities in the pseudo-random sequence of numbers representing A-4. It would probably be desirable to generate another set of random numbers, i.e., another pseudo-A, for further comparison.

Goodness of simulation

The product-moment correlations between the performance likelihood rankings over all Bs in all situations for all simulators and simulands is given in Table 2. This matrix is divided into three sub-matrices: I, II, III.

Insert Table 2 about here

Sub-matrix I shows the correlations between rankings made by the As. These correlations are moderately large, although smaller than the correlations between As for the baseline judgments (cf. Table 1). Only for the correlations between A1 and A3 are the observational judgments correlated significantly less than the baseline judgments ($p < .05$, two-tailed) (N of observational judgments = 2550; N of baseline judgments = 1878).

Sub-matrix II (Table 2) shows the degree to which each simulator duplicates the total observational judgments of the simulands. The

underlined elements of this sub-matrix are the correlations between simulator and corresponding simuland. In each row, the first underlined element is the correlation for the simulator by Maximum Want Rule and second underlined element is the correlation for the simulator by Total Want Rule.

For the genuine As, these diagonal values range from .38 to .50, and are all significantly different from zero.

Discriminant simulation

Each underlined element in sub-matrix II should be the largest in its row (excluding the other underlined element) and column of sub-matrix II. Most differences are in the right direction, except that $r_{A1,A1Max} = r_{A2,A1Max}$; and $r_{A2,A2Max}$ and $r_{A2,A2Tot} < r_{A2,A1Max}$ and $r_{A2,A1Tot}$.

Correlations between simulators are given in sub-matrix III. Diagonals are correlations of the two simulators (one for each Estimation Rule). Discriminant simulation requires each diagonal entry in sub-matrix III to be highest in its row and column in sub-matrix III. All meet this requirement.

Discriminant simulation requires diagonals in sub-matrix II to be higher than off-diagonals in sub-matrix III, otherwise the simulators resemble each other more than they resemble their appropriate simulands. For A2, the simulation is clearly more like A1Max, and probably more like A1Tot, than like A2. For A3, there is a similar tendency, although not statistically significant.

Differences between Estimation Rules

There seem to be no differences between simulators according to Estimation Rules, either in 1) goodness of simulation (cf. underlined

elements of sub-matrix II) or in 2) discriminant simulation (row and column comparisons, above).

Possible trend differences between the two rules were informally tested by inspection of the graphs, situation by situation, of mean Spearman rank correlations over 10 Bs (Figures 1 and 2). These graphs indicate no differences in trends between the two rules.

Insert Figures 1 and 2 about here

Another measure of the differences between the two simulations is the error of rank-one prediction. This is defined as the difference between the rank given by A to the most likely performance, i.e., rank one, and the rank given that same performance by the simulation. For example, if A ranks performance number five as most likely in a specific situation, and the simulation ranks performance number five as fourth most likely in the same situation, the error of rank-one prediction in that situation is three.

Insert Figures 3 and 4 about here

Mean error of rank-one prediction was also graphed by situation over 10 Bs (Figures 3 and 4). For pseudo-A, A4, the mean error of rank-one prediction approximates the expected rank difference between any two ranks randomly assigned within 17 positions, i.e., 8. For the genuine As, the Total Want simulation has a consistently smaller error of rank-one prediction than the Maximum Want simulation, although there seem to be no trend differences. The error of rank-one prediction is consistently lowest for A1.

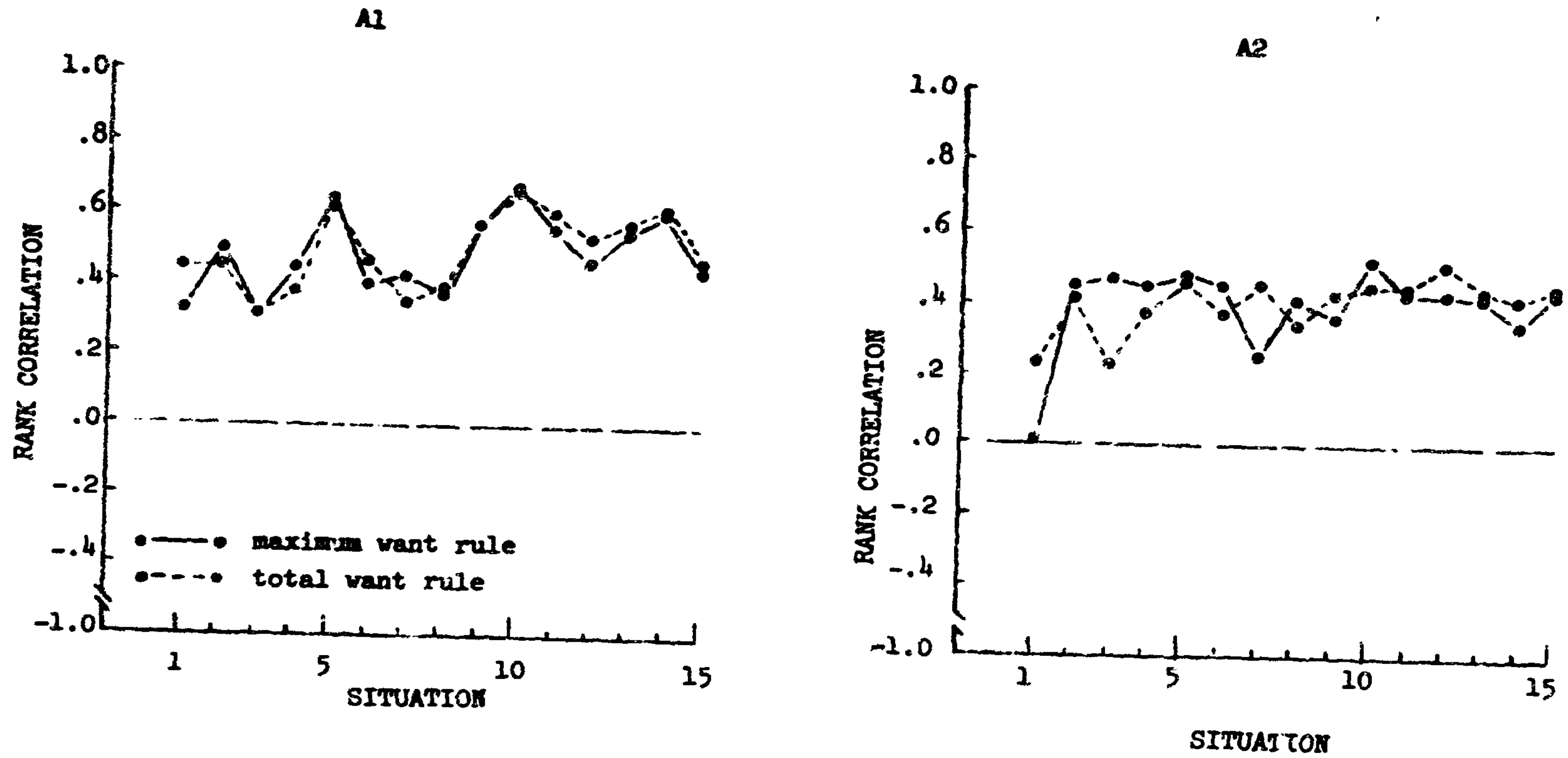

Figure 1. Spearman rank correlation between ranking of performance likelihoods by A and ranking by simulation of that A. Mean over 10 Bs.

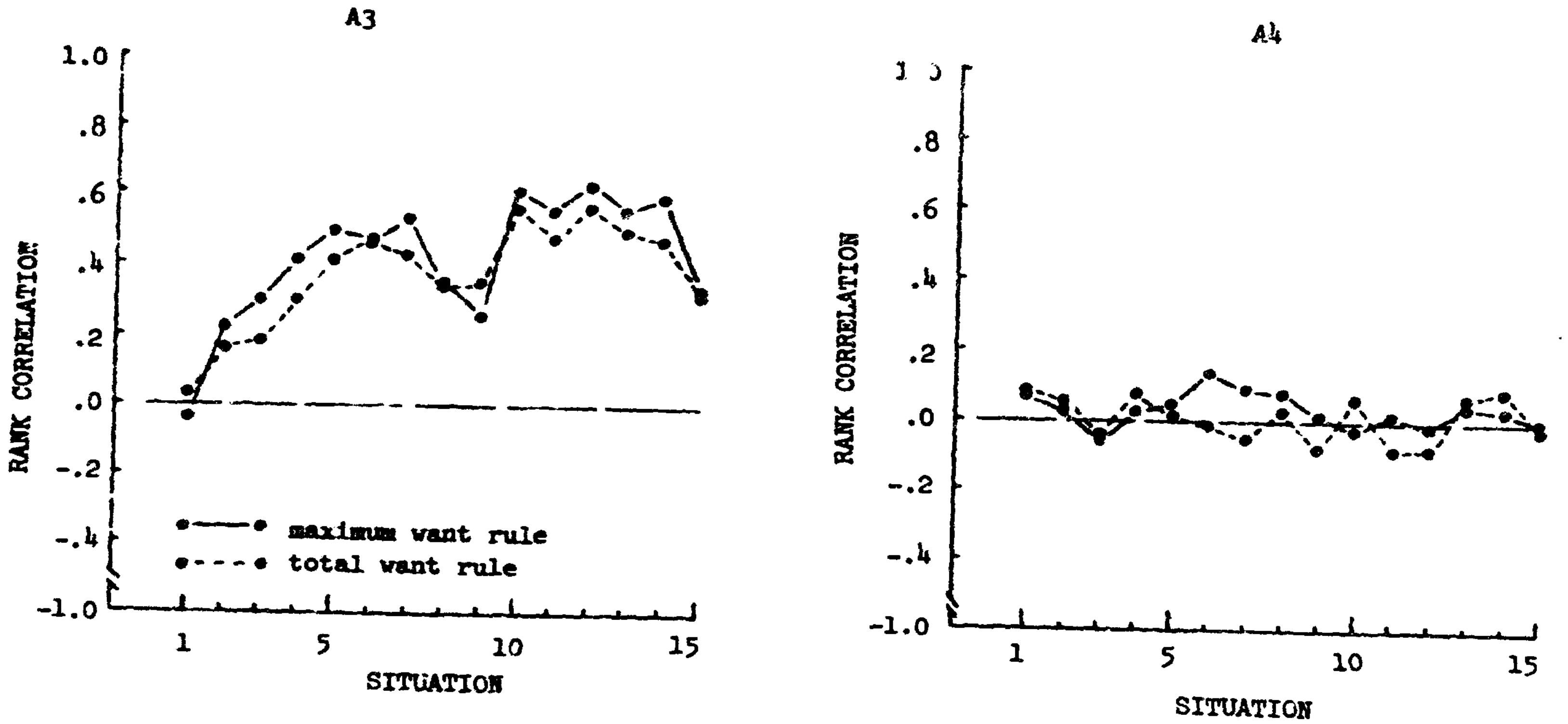

Figure 2. Spearman rank correlation between ranking of performance likelihoods by A and ranking by simulation of that A. Mean over 10 Es.

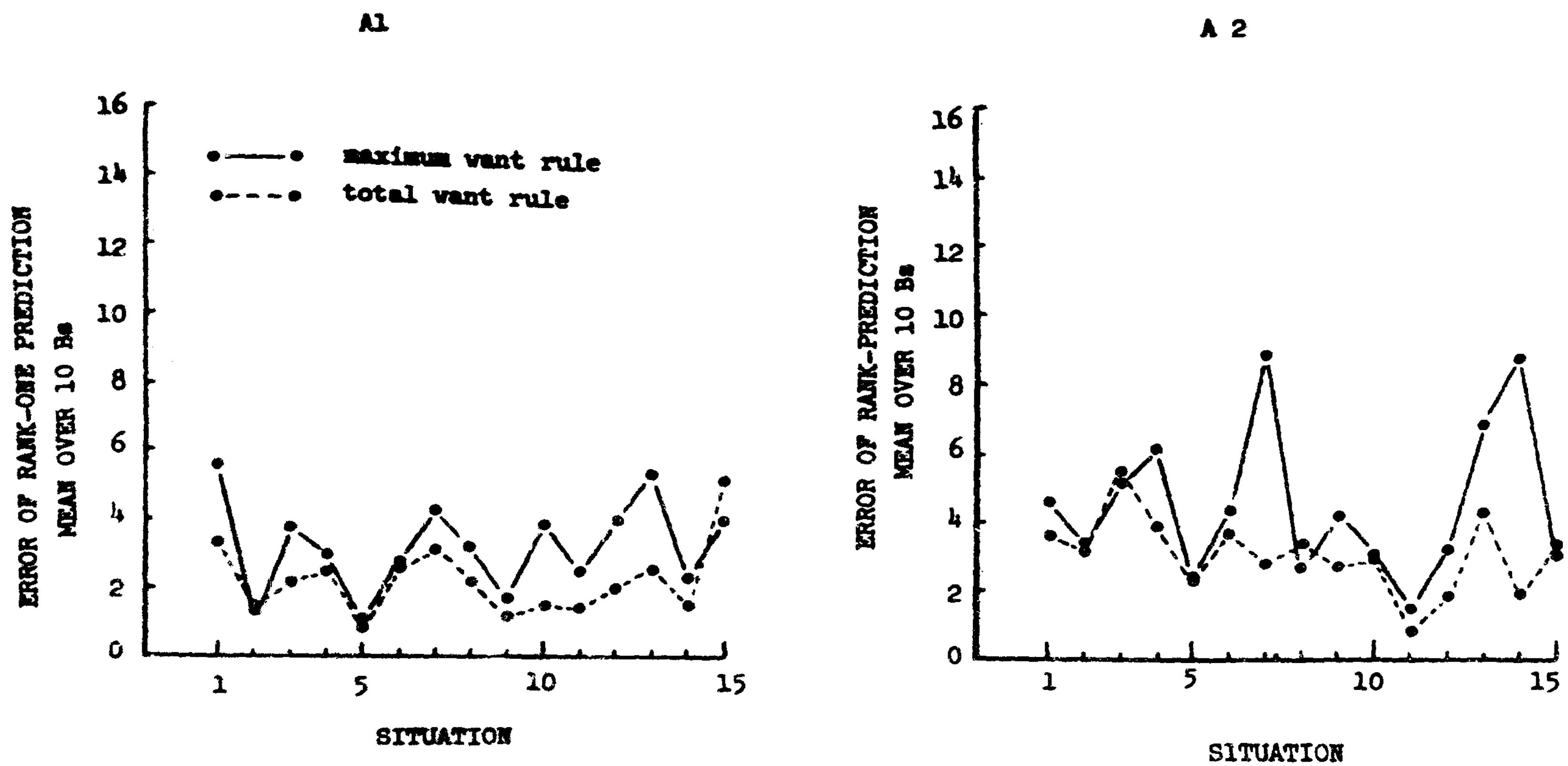

Figure 3. Error of rank-one prediction. (1 - rank given by simulation to performance ranked most likely by A.) Mean over 10 Bs.

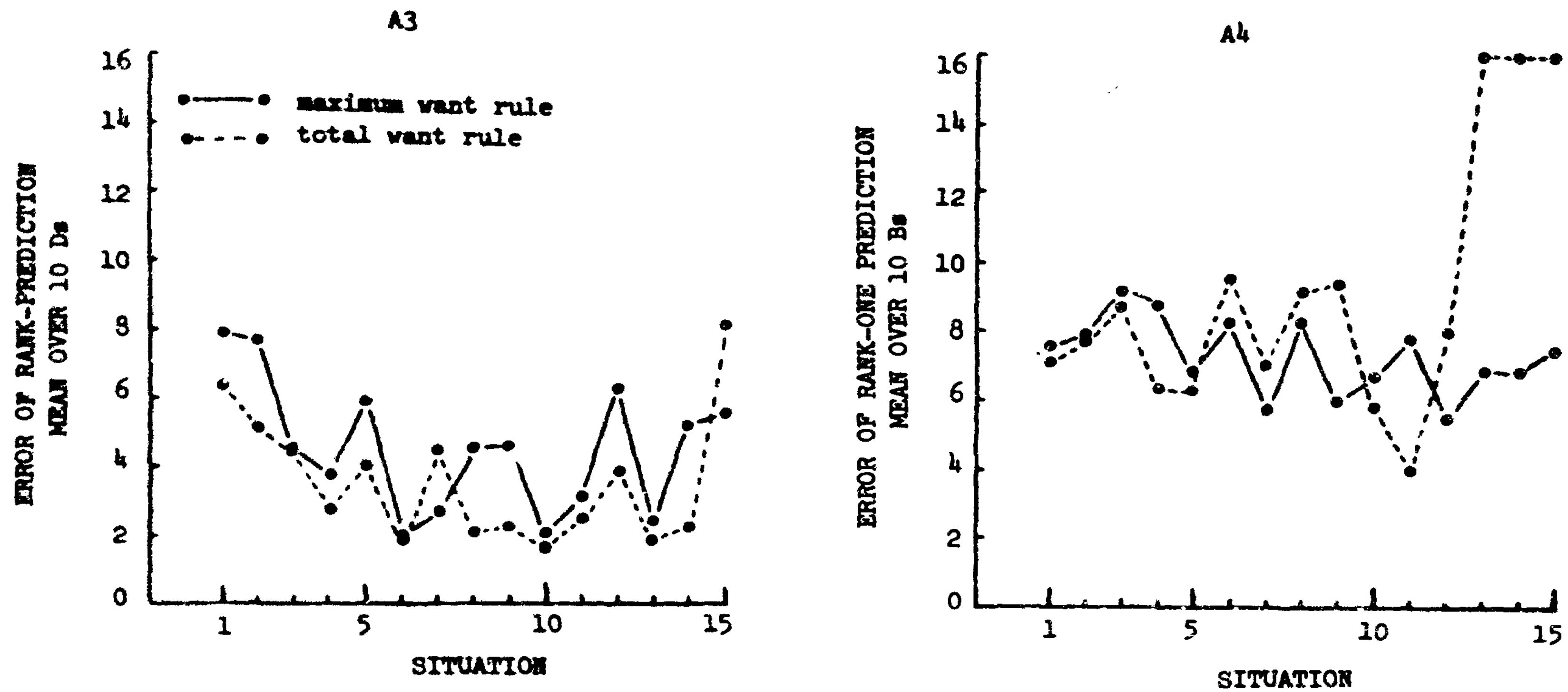

Figure 4. Error of rank-one prediction. (1 - rank given by simulation to performance ranked most likely by A.) Mean over 10 Bs.

Discussion

The simulations seem to be successful and promising. Procedurally, the parameters employed in this simulation seem to be relevant; the task of giving values on the parameters is meaningful for the subject As, and there is a fairly high correlation among As' ratings on these parameters.

Although the correlations by which goodness of simulation are assessed are only moderately high (.38 to .50), they seem to be satisfactory. There are so many simplifications in this simulation that much higher correlations might indicate some artifact. For one thing, the revision by feedback concerned only the observed performance. The simulator had no knowledge of, nor did it compare itself with, the total rankings of performance likelihood. Revision of the parameter assessment effected total rankings only indirectly, since by raising the general intensity of, and lowering the constraint against, a single want, that want had greater influence on total performance likelihoods in future situations (see equations (1), (2) and (22)).

Furthermore, the feedback given the simulator is minimal. For example, in the situation of the movie-ticket line, one B said, "I would probably do nothing, but am most likely to say, 'Haven't you ever heard of waiting your turn?'" The As resolved the ambiguity in this response by categorizing either the first or the second part of the response as the observed performance. A1 called this response performance 5, "Tell C to stop"; A2 called it performance 12, "Ignore C and C's actions"; A3 called it performance 3, "Insult C". It hardly seems likely, however, that the As would forget completely the part of the reply which they ignored in categorization. Thus A2 might expect that this B would be

more likely to act aggressively in a hostility-provoking situation than a B who simply said that he would do "Nothing" in the movie-ticket line situation. Yet, as far as the simulation was concerned, both Bs would be identically treated; their wants, constraints, and performances would be corrected in exactly the same way.

Finally, this simulation takes no account of the ways in which combinations of parameters might vary, either between individuals, or within individuals. For example, one person might always take into account constraint more than another observer might. Or, the same observer might regularly judge one kind of situation differently from another, e.g., he might judge hostility-provoking situations differently from those involving affection. Or, the same observer might judge some class of persons, e.g., authority figures, differently from other classes of persons.

To say that this simulation is acceptably successful is not to say that there are no difficulties with it. For one thing, A2's performance is different from the performance of the other As and seems relatively unsatisfactory. A2 seemed less certain than either A1 or A3 of the meaningfulness of rankings in the middle range; she was not as certain of her accuracy as were the other two As, except at the extremes of most likely and least likely performances. Furthermore, A2 was a female, and may not have been as skilled in dealing with hostility-provoking situations as the other two As, who were male.

Besides the problem of A2's performance, there seems to be another problem, viz., a strong experimenter effect. The simulation worked differently for A1, the experimenter, than for the other As. First, A1

was correlated more highly with each of the other genuine As than they were with each other. Second, the simulated A2 and simulated A3 were more like simulated A1 than they were like their respective simulands, even though they were more like their simulands than they were like each other (cf. sub-matrix II and sub-matrix III, Table 2). Third, the correlation of A1 with the pseudo-A, A4, was consistently closer to zero than were the correlations of A2 and A3 with A4. Fourth, by both measures of goodness of simulation, the correlation of entire rankings and the error of rank-one prediction, A1 was more successfully simulated than were the other As.

It is not clear how this effect can be explained. It might be that the categories of performances and wants reflected some bias on the part of A1, the experimenter, and constrained the other As. This might be handled by having the As devise their own performance and want examples. Or, it might be that the Estimation Rules devised by the experimenter were particularly appropriate for him and less appropriate for other persons. This difficulty might be remedied by having each A devise the Estimation Rules which would be applied to himself.

Summary

This study concerned the computer simulation of persons who made observational judgments of other persons. In this report, observational judgment was discussed in terms of the Person Concept (Ossorio, 1966); the parameters for the computer simulation of observational judgment were drawn from the Person Concept.

The method employed in this study was computer simulation. A brief discussion of simulation suggested that the representation

undertaken here might be called an "outcome" simulation.

The procedures of this study involved a person, A, who observed another person, B, reacting to a third person, C, in a hostility-provoking situation. A judged B's reactions and predicted his reactions in future situations. The computer received both A's general estimation of actions in hostility-provoking situations, and A's categorizations of the performance manifested by B. The computer was programmed, according to Rules described in this report, to combine this information so as to duplicate A's predictions of B's future behavior.

The results seemed to be promising. Although the simulation was only moderately good, it was pointed out that the simplifications employed in this simulation should explain why it was not better. Several possible ways of improving the simulation were mentioned. These included: 1) attempting to take into account individual differences in observers, both with respect to persons observed and situations observed; and 2) permitting the observers simulated to devise their own want and performance examples and Estimation Rules.

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Appendix S

Activity Analysis

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Note: This is not the paper by Felknor which is referred to in Appendix Q

To describe a particular behavioral episode as an instance of a particular intentional action is to say in effect, or to commit oneself as a describer to the fact, that: (1) The person wants something or has reason enough for doing something which the particular action is aimed to achieve. (2) The person is engaged in an overt, observable behavioral process which represents his attempt to try to get what he wants or has reason enough to try to get. (3) The person knows something relevant to the action, such as he knows that this particular performance can be expected to get him what he wants. (4) And, finally, the performance is a demonstration of the person's ability, skill, competence or know-how, and its occurrence is neither accident nor coincidence, but rather is repeatable with variation under appropriate circumstances. A describer in offering an <u>action description</u> of a <u>particular</u> behavioral episode is committed to saying what the <u>content</u> is of these more general, structural, concept types. That is, in giving the <u>action</u> <u>description</u> he is "filling in" the particular content of the more general concept types. Thus, to describe a person as engaged in the action of "writing a paper" is to say simultaneously that: (1) The person has reason enough to write such a paper (wanting to write such a paper for its own sake being only one possible reason). (2) What the person can be observed to be doing (i.e., his overt attempt or performance) is recognizable as the same kind of thing that a person would do who was trying to write such a paper. (3) The person knows and expects that what he is doing will lead him to

such a finished written product (i.e., a paper). In addition, or at a minimum the person knows the difference between such a written paper and other things or other achievements. (4) The person is demonstrating his ability, skill or competence in his attempt (i.e., performance) to write such a paper.

To describe a particular behavioral episode then, as an instance of a particular intentional action represents a rather extensive commitment on the part of the describer along with the implication that he has rather complete information regarding what the person is doing. In addition, the action description carries the further implication that the more extensive is the descriptive commitment the more chances there are for descriptive errors.

Several conclusions are possible relative to the describer who offers an action description: (1) The describer is in a position to have rather complete information about the person engaged in the particular action, e.g., he himself is the acting person and hence it is a first person description he is proffering, etc. (2) The describer is simply "going out on a limb", perhaps making "educated" guesses, and giving action descriptions with some abandon because descriptive errors are of no particular serious consequence to anyone. (3) Or, perhaps the advantages of completeness or commitment outweigh the increased possibility of error. It is perhaps best emphasized here in this present context that the describer, who, of course, is a person too, is engaged in the use of concepts (or better the use of descriptive systems) in making and offering his descriptions of behavior, both of his own

and of other persons. Thus, making a description is an instance of intentional action, any instance of <u>which</u> action depends of course on the descriptive system (i.e., concepts) being used by the describer, the use of which being dependent upon what the describer wants to accomplish through his description (or to what further end the particular description is meant to contribute). The major point to be made is that to offer an <u>action</u> description <u>is</u> one kind of action, while offering a <u>performance</u> or a <u>social practice</u> or an activity description is another kind of action having quite different implications. To give the various forms of behavior description of the same behavioral phenomena is simply to treat the same phenomena differently on each such descriptive occasion. It is accurate to say that all of the various forms of behavior descriptions are just <u>that</u>, forms or variations in the descriptions of the same phenomena, which is the behavior of a person, and hence is his engagement in <u>some</u> intentional action.

In a very real sense, to describe what a person is doing as "behavior" is <u>the least possible descriptive commitment</u> of what a person <u>could</u> be doing. About all the describer is committing himself to is that it is <u>a person</u> and that a person is <u>doing</u> something rather than the phenomena being something that is happening <u>to</u> a person. Thus to speak of various forms of behavior description is to have already implicated <u>some</u> person engaged in <u>some</u> action, the various forms of description all being descriptions of the same particular action and all representing varying degrees of commitment about which particular action it is. It is

appropos to point out here that there is no intended implications to the effe that any of these forms of behavior description is more basic or more accurate than another. Rather these forms of description represent the application of different descriptive systems, among which is a rather large degree of overlap.

The descriptive system which accounts for action descriptions was presented above as being articulated into the paradigm constituted of four structural, concept types: want, know, know-how, and performance. When this descriptive system is applied in the form of an action description, the person making this application becomes committed to saying in effect what the particular content of these four structural concepts is on this particular action occasion. Of special interest here is the describer's commitment to say what the person's reasons are for engaging in the action, which is in effect to name the action. Therefore, to say that a person is engaged in the action of: Cooking a steak is to say in effect that his reasons for doing what he may be observed to be doing (i.e., his engagement in that performance) is to get the steak cooked, whatever else may be the fate of the steak thereafter. Thus, to say what a person's reasons are for engaging in a particular behavioral process is to "fill in" the content of the want concept type.

There are several kinds of reasons which are applicable to the concept type of want here. For instance, a person may simply want something (including want to do something) sheerly for its own sake or, as it were, because he likes that. But such a

sense of wanting or desiring qualifies as only one kind of reason here. To want something (or to want to do something) because it serves as a means to some further end which is itself wanted for its own sake also qualifies as a kind of reason.

There is also a third kind of reason to be distinguished here and that is the sense of want where a person wants to do something only in the sense that that something is a part of something else which is also done for some kind of reason. The first sense of want then is like the person who wants to eat a steak because he simply likes steak. The second sense is like the person who eats steak in order to maintain a high protein diet, this is especially the second sense of want if the person does not particularly like steak or even dislikes it. Thus, he is eating the steak not for its own sake, but rather as a means toward some further end. (Eating steak, of course, must not be the sole means of maintaining a high protein diet or else this use of want shades over into the following sense of want.) To want to chew one's steak is simply part of eating steak, and represents the third sense of want distinguished here. This latter sense of want is a convenient vehicle for attempting to make the point that it is sometimes really quite inappropriate even to ask what a person's reasons are for doing some things let alone asking what it is that he wants when he does some of those things. Thus, to ask what a person's reasons are for doing certain things is really to be asking for the point of his doing those things. To ask what the point of some action is, is to be asking for the past relationship of

that action to some more inclusive action context. Thus to ask a person why he tried to return that serve in a tennis game would be to ask what is the point of returning a serve in a tennis game. And, that would be to expect to receive the answer that the point of returning serves in tennis games is just part of the game of tennis which is, of course, an intelligible social practice. To anticipate the discussion a bit, one way of saying what the point is of some particular action is to cite a social practice and hence its corresponding descriptive system of which the particular action in question is a part. One might say then that in any ascending string or series of related requests (i.e., more inclusive contexts) for reasons for what a person is doing there is always that point where asking for such reasons ceases to be appropriate and yields to a more appropriate explanation in the form of establishing the point of the particular behavior. The point is usually established by citing the relevant social practice(s) of which the particular action is a part. Before discussing the concept of social practice, its corresponding descriptive system, and the rather obvious relationship between social practice descriptions and action descriptions, it seems appropos at this juncture to discuss that form of behavior description referred to here as the performance description and its part-descriptive relationship to the action descriptive system.

As can be seen in the articulation of the paradigm of intentional action (i.e., the action descriptive system) that descriptive systems corresponding to the concept of performance is

a part of that descriptive system corresponding to the concept of intentional action. In terms of the degree of commitment on the part of a user of this performance descriptive system in describing a person's behavior, the performance description perhaps represents only a slightly greater commitment than the description of the person as merely "behaving". The performance description is a case of a part description (see Ossorio, 1966) relative to a particular corresponding action description. That is to say, that for a describer to employ a performance description is for him to remain formally uncommitted regarding which action this overt behavioral episode is a part of; it is for him to remain uncommitted regarding not only the person's reasons for doing that performance, but in addition there is a formal lack of commitment regarding even what the person knows and knows how, the remaining constituents of the action descriptive paradigm. All that is being formally claimed is that a person is engaged in a behavioral (i.e., or psychological) process which is the same kind of process or locution: looks like--as verbal distinction--looks like the kind of process that a person would be engaged in if indeed, in actuality, he were engaged in an instance of the particular action concept which would be described by the descriptive system corresponding to the particular action terminology labeling the performance. That is to say, that there is no other recognized and accepted way of describing this behavioral process or performance other than by referring it to some action descriptive context, by way of saying that the process looks like the

process that might be intelligibly engaged in (i.e., by a person who knew) by a person who had the necessary competence to achieve a particular end (i.e., by a person who knew how) and who wanted or had reason enough to try to achieve that particular end. It is important to note that there is always some action description which shares its terminology and hence part of its descriptive resources with any particular performance description. Thus, even though there may be no verbal distinction extant in the language between a particular action description and a particular performance description there is a clear and purely formal distinction being made between the actions which are engaged in by the describer; the distinction being mainly in terms of the degree of commitment being made by the describer regarding the particular action in which the person described is engaged. The action description, of course, represents a complete commitment, while the performance description represents a near minimum level of commitment. There is, of course, the situation (perhaps it is the usual situation) where differences in commitment are as it were unnecessary due to the fact the action being engaged in is accurately described by the same action descriptive system which shares its terminology with the part descriptive performance description. Thus any mistakes regarding which kind of description (either an action or a performance) was being presented would be of little consequence in terms of the accuracy of the action descriptive account. It should be recalled, however, that a describer may not be in an informed position to assess the accuracy

of an action description, and hence may wish to proceed more cautiously by remaining uncommitted in this descriptive regard.

While the possibility of the usual situation is being discussed it is perhaps wise to discuss the usual relationship between the performance aspect of the intentional action paradigm and the remaining three aspects of the paradigm, i.e., know, know-how, and want, with special emphasis on the relationship between the want and performance aspects. As a general rule there is neither a direct connection between wanting something and getting something nor between wanting something and trying to get something. In the paradigm case of the concept of intentional action there is, however, normally a direct connection between trying to get something and getting it or making the achievement. That is, the paradigm case of intentional action is a case of a successful action (i.e., involving a successful attempt), and it is only by reference to some case of successful intentional action that so-called unsuccessful actions are even describable. That is, it is only by reference to that descriptive system corresponding to some particular action (success being implied) that it is possible to describe an unsuccessful attempt to achieve what that particular action description is geared to provide a description of. Thus the intelligibility of an error in arithmetic relies on that descriptive system corresponding to the notion of arithmetic done correctly or successfully accomplished. That is to say, that getting the wrong sum in addition is formally then not an instance of addition--rather it is a failure at addition or a

success relative to some _other_ action, the successful accomplishment of which would have given the identical sum which was arrived at.

The relationship between want and performance is usually one of means to ends, the performance being the means to the wanted end. Thus, to get something that is wanted one must _do something_ to try to get what is wanted, that is one must engage in a performance or an overt attempt of some kind. Another way of saying the same thing is to say that the performance is the process whereby the particular outcome is achieved. Relative to an intentional action the performance is also seen as being, before the fact, and intelligible means to a wanted achievement. But what of the situation where there is little or no distinction between what is wanted (i.e., the achievement) and the performance? That is to say, that to do _that_ (_i_._e_., _the performance_) is what is wanted, the performance does not stand as a means to another end, unless it (the end) is itself.

There are two ways one may go here in coming to grips with this situation, one of these moves is to a different form of behavior description, the activity description; the other move is to what might be called a brute level of description.

The brute level of description may be characterized best if one thinks in terms of a descending string or series of questions (i.e., less inclusive contexts) asking for a person's reasons for doing something--or as it were, asking of a person what it was he wanted to do (as a means) _before_ he could hope to get

what he really wanted--and back and back. For instance, although it was acknowledged that the person was engaged in the action of drinking a cup of coffee, with the implication that he wanted the coffee, what did he first have to want (as a means to an end) in order to accomplish getting a drink of coffee? Did he not just by some means want to obtain a cup full of coffee, and before that want to fill the cup, and even before that want to get a cup to fill, etc., etc., down to some point where we are asking a question such as: What did the person first want and know how to do that allowed him to achieve what he now must want in order to achieve that further wanted end? It is at this level that there is no distinction to be made between performance and achievement--one might characterize this descriptive level as the pure performance or brute fact levels of description. A pure performance is something like reaching, lifting, pushing, etc.; in these performances there is nothing that one knows how to do prior to or in order to do them. They are as it were accomplished directly by anyone who knows how to do them. Only under special circumstances does a person behaps learn something else which allows him to accomplish sure pure performance forms (e.g., a previously brain damaged person may find it necessary to learn some muscle coordination technique which will enable him to extend his leg and thus allow him to walk).

The other move available here is the situation where there appears to be little distinction between, as it were, a "performance" and that which a person wants, is the move to what

is referred to here as the _activity description_. The conclusion to be anticipated here is that an activity is rather like the "performance" aspect of an action that is done for its own, i.e., a social practice. So activity is to social practice as performance is to action, with the exception that an activity is not conceptualized as a _means_ to an end as much as it is as a part of a more inclusive, intelligible whole. It is in this sense that it is said that activities and social practices are things that persons _know how to do_, as it were, before the fact. That is, the behavioral process is in certain respects and within certain limits _standardized_.

From the foregoing discussion two things have been implied about the concept of social practice and its corresponding descriptive system: (1) A particular social practice is sometimes invoked as an explanation for why a person is doing something, e.g., engaged in a particular action or even another social practice at a less indusive level, an explanation in the form of establishing or saying what the point of his doing that is or could be or even might be.

Another thing implied about the concept of social practice has been that social practices, as such, are or may be done for their own sake alone with no further end in view. Thus to describe a person as being engaged in a social practice is like an action description in that a commitment regarding either the person's reasons or the point of his doing that is made. To say that a person is engaged in a particular social practice is to say that no further reason need be offered (other than the fact of his doing that) for his doing that--that that is just one of the things that are done. A list of social practices would be a list of behaviors engaged in by a particular group of persons (e.g., a culture) and found to be intelligibly done by those persons without any additional justification other than perhaps that this particular behavior is one of the things that constitutes a way of life. For any particular culture there is (at any given time) a finite, but indefinite number of particular social practices. That is, there is a limited number (although an indefinite number, i.e., one would not know when or if he had ever sucess-

fully compiled a complete list) of separate things a person could be said to be doing intelligibly in a given culture.

It would not be misleading (although not to be taken quite literally--as a social practice is simply an intelligible thing to do in its own right) to describe a social practice as a collection or set of intentional actions which ordinarily have a complex organization and interrelationship. It is because a social practice is such a set of actions that any of the actions which constitute one of these sets members or parts may be redescribed as being a part of the social practice by simply describing the person as being engaged in that social practice (akin to partial description)--the part of the practice may not be specifically designated. There is, of course, always a social practice of some kind that the person is engaged in--but it may make some sense to not go that far--and say that it is an intentional action--which is perhaps not quite as great a commitment--by calling it an action rather than a social practice is to say that it is not being done for its own sake (although it could be) and not saying what social practice it is or is a part of.

The major attempt here in this section of the paper is to draw some meaningful distinctions between action descriptions and social practice descriptions on the one hand and between performance descriptions and activity descriptions on the other. It would seem that the most useful distinctions (toward the end of understanding) would be in terms of use. That is, a describer making one kind of description rather than another is engaged in

different actions depending upon the descriptive form that is being applied or the kind of description that is being offered. Consequently, if different actions are involved then different reasons, and perhaps different <u>knows</u> and <u>know-hows</u> too are involved.

One might ask then what P is doing or is <u>not</u> doing, or is trying to achieve or is trying to avoid, etc. in engaging in the several descriptive actions?

When O as a describer offers an action description of P's behavior as opposed to a social practice description, O is as it were leaving open the question of whether the particular action is being engaged in for its own sake alone or whether it is being engaged in as a means to some further end. In one sense the action description is a bit less committed than the social practice description in the sense that to offer an action description is to leave open the possibility that the action may be being engaged in as a means to some further end, and, that it is legitimate to inquire further about what that further end might be. In a sense this inquiry into further ends is a request for a social practice description (or redescription). It may be, of course, that the action was being engaged in for its own sake, and in that case a social practice description could have been offered without its being inaccurate. It is in this case that the social practice description and the action description, terminologically at least, are effectively the same.

There are, we might say, two classes of actions: (1)

Those actions which have as reasons ends that are intelligibly wanted for their own sake--i.e., no further justification or explanation is needed or called for, and (2) those actions which have as their ends things that are not intelligibly wanted for their own sake, but which might be understood as parts of or as means to some other end which _is_ intelligibly understood to be wanted for its own sake. That larger or further intelligible whole of which this latter class of actions might be a part is mainly what is meant by a social practice. This whole might effectively be described (or redescribed) as an action of the first kind, that is as having _itself_ as its reason for being done. That is, it is something which is intelligibly done for its own sake. It is mainly in this sense that there is overlap in the application of these concepts of action and social practice. Normally we tend to think of social practices as being of a larger scope than we think of actions. Larger scope in the sense of implicating larger and more complexly organized domains of behavior. A similar way of viewing the relations between a social practice and an action is by seeing the social practice as a complexly organized set of actions (some of which might, of course, be viewed as social practices themselves with still other action as _their_ constituents). That is, the constituents of social practices are _actions_, even though some of those actions in their own right might for _other purposes_ be redescribed as social practices at some less inclusive level. It is also important _not_ to think that the relation between a particular action and its social practice is always one

of means to end, for it may as well (and more intelligibly so) be a relation simply of part to whole. There is also, of course, the case of maximum overlap in these notions--the case where the social practice has an action constituency of one. In this case there is virtually no difference (at least terminologically) between an action and a social practice. Because the action is as well a social practice then the implication is that the action can be and in this case is intelligibly understood as being done for its own sake.

It is now time to come to grips with the notion of activity and activity description. The notion of activity basically stands in the same relationship to the notion of social practices as the notion of performance stands in relation to the notion of action. Thus, an activity description is a part description relative to a particular social practice description. Although the activity process or sequence may occur independently of a particular social practice context (i.e., perhaps its primary context --the social practice description with which it shares its terminology; see Ossorio's discussion of part description). A performance description is, of course, too, a part description relative to some particular action description. In the sense that action descriptions and social practices descriptions are related (even overlap) there is, of course, the sense in which activity descriptions and action descriptions are highly related. Thus, an activity description like a performance description is a description which makes no commitment regarding P's reasons (i.e., among

which reasons are of course social practice contexts) for doing that behavior. That is, an activity description makes no commitment (i.e., formal commitment nor mention of) about which particular social practice P is in fact participating in. The nature of the commitment is of the form: P is participating in an activity which looks like the same activity he _would_ be participating in if in fact he were participating in social practice X, but I am unwilling (for several reasons) to commit myself to stating as fact that P _is_ participating in social practice X.

There are two other additional features (parameters) that distinguish activity descriptions from performance descriptions: (1) An activity description makes a greater commitment about the relationship between P and what he is doing in the sense that an activity description formally implies that P _knows_ what he is doing in the sense that he knows how to do that _beforehand_. Social practices are, of course, things that persons as a rule know about which implies that they know how to do them or at a minimum are able to recognize their occurrence as intelligible, maybe even familiar culturally. There is the further implication that the person knows (i.e., _is aware_ of at a minimum) what it is that he is doing and is intending to do just that (or would do just that if he were aware _that_--and could say). Thus, there is sense to the statement that activities are things we _know how to do_ and it is the activity's intimate relationship to its social practice that gives it this sense.

Basically what one is accomplishing in offering an

activity description is the <u>identification</u> and <u>description</u> of a behavioral process or sequence (<u>some</u> intentional action, i.e., behavior). The advantage of the activity description is that the set of events may be described (as the kind of...) without being committed to saying which action or social practice the behavioral process is. Rather, one is taking advantage terminologically of the descriptive resources of the action-practice systems by saying that the set of events are the <u>same</u> set of events that would occur if one were engaged in that social practice--and did know that those events were what he was engaged with <u>and</u> that he knew in advance how to do those things (i.e., his role in relation to those events P-roles).

One might say that a performance description was a part description relative to the activity description. That is, a particular performance description is offered by way of saying that those events are the same events that would have occurred if the person had been engaged in a particular activity--an activity signifying the same events that would have occurred if the person were engaged in a particular performance. The performance is the same as it would have been if the person had known and had known how to do it. Only in this case there is no descriptive implication that the person did <u>know</u> that that was what he was doing, nor did he <u>know how</u> to do <u>that</u> as opposed to something else.

It would be possible to be in error in making a particular activity description in the following way: That is the particular activity description would have been accurate if the

person had known that it was <u>that</u> performance (including knowing that that performance would be likely to have <u>that</u> outcome) <u>and</u> that the person knew how to do that performance beforehand (including that the outcome was not an accident nor unintended and it could be repeated). The error here in <u>action terminology</u> basically is that the wrong action has been cited (or implicated by the particular activity description) for the particular performance. One might say, therefore, that the performance is not the performance of that particular activity and hence of that particular action or social practice, but rather is the performance aspect of <u>another</u> action (or could be) and hence would be the performance aspect of a corresponding activity description. For instance take a situation like the following: It is the descriptive task to describe what P is doing (let us say mainly in the form of activity description). We are in effect asked to describe the behavioral episode or set of events in which P is engaged. We may say that P is engaged in activity X--that is to say that we are saying that the set of events in which P is engaged looks like the same set of events that P would be engaged in if he were participating in social practice X. The activity description is couched in action-practice terminology (most of the descriptive terminology is of this sort--there is very little activity and performance terminology, etc. [activity "taking a walk" performance jump, reach, pull, push, etc.]). This description, because it is an activity description, is not at all saying that P <u>is</u> participating in social practice X, for it could be and

it is descriptively left open, that P could be participating in quite another social practice, e.g., (1) one which was different in detail in the sequence of events (this would constitute a simple error in description because the particular set of events was not accurately described), (2) a social practice of either a more or less inclusive level than the one mentioned or implied in the activity description, e.g., a person described as _farming_ (because he was plowing) but who was really doing Ag research. The activity description was not in error but was potentially misleading and perhaps could have been less commital by describing P's behavior simply as plowing or at some lesser level of scope.

But what of the situation where P is engaged in an action or social practice which is in no way implicated by the descriptive terminology. In fact, P is simply unaware that his behavior is the same sort of thing that is described by these descriptions. In a sense one might say that P is unaware of _some_ of the consequences which regularly accompanies the set of events he is engaged in--maybe he is even unable to recognize the situation. The upshot of this is that some of what P is doing is describable as an _unintended_ action (i.e., outcome) or as not even an action at all if P did not have the requisite ability to bring it off again by design and not by accident. In a sense then a performance description would perhaps have been the least commital and even the least _misleading_ description that could have been offered.

The main point to be made is that of trying to indicate that an activity description is a greater commitment than is a performance description. The activity description amounts to a commitment to the effect that the behavioral sequence being engaged in by P is something he knows he is doing (or at the very least, is something that is in his repertoire to know he is doing; that is, he could know he was doing it if he were attending--there is at a minimum an "aware _of_" sense of know) and something he knows how to do beforehand (that is, what is being done is intelligible in its own right as a part of at least one particular social practice and, of course, perhaps numerous others at the same and different descriptive levels). The performance description, on the other hand, makes no commitment on either of these counts. The performance description in one sense is just one step removed from a simple description of the outcome or achievement of a behavioral process.

It is important to reiterate that some of the more crucial differences among the various forms of description are to be found in the uses of the descriptions by the person(s) doing the describing (and perhaps the observing, too). Thus, a person offering an action description is saying something about P's reasons, whereas the person offering the activity description is not attempting to say anything about P's reasons. In fact, for whatever reasons _he_ has, he is avoiding any such commitment.

Now to become more specific about the notion of activity analysis. An activity analysis is clearly an _analytic_ task.

That is, a whole is analyzed, articulated, or broken down into its constituent parts and the sequential relationships, if any, among the several parts is specified.

As mentioned earlier, any behavioral episode is a process (e.g., it is datable and clockable); hence to describe (via analysis) an activity is to describe (i.e., analyze) a process. And further, the most direct analysis of a process (e.g., an activity) is into other processes. Hence, the initial breakdown of an activity is into other activities (i.e., sub-activities). These sub-activities may then perhaps be broken down still further into even less inclusive sub-activities of sub-activities, and so on. One might describe these various potential levels of analysis as being equivalent descriptions of the same thing (when all parts at a given level are taken together), namely, the activity being analyzed and identified by a particular terminology at the outset. Not only are the parts identified (perhaps described, as well), but the sequential relationships among them must be specified, or, if it is not required, it must be specified that sequential relationships are not required. Presumably, some sequential ordering is always to be found at some level of analysis.

There are two distinct classes of "parts" being mentioned here: (1) individuals (e.g., psychological objects and physical objects) and (2) process parts, phases, stages, etc. Thus, in analyzing a process, one specifies (1) the primary components, (2) the relationships between these components, (3) changes in any relationships between any of the components, and (4) the sequence of changes

in relationship between components, i.e., the sequence of events. A further elaboration of the analysis involves specifying various activity positions. An activity position is the particular relationship between a particular individual (e.g., a person) and other particular individuals of an activity, including, perhaps, how that (or those) relationships change over the course of the process.

The identification and specification of component individuals (persons or other objects) is generally quite straightforward in the sense that they usually are the most naturally selected or obvious candidates. This specification is hardly arbitrary in the sense of making it possible for just anything to be dubbed in as a component. If there are grounds for making one choice over another, then reasons for a choice can be offered, but it can hardly be supposed that there is some methodological criterion which, if we but knew, could guarantee that a given choice was the _right_ choice. Separating out various part processes is a similar case. There are reality constraints here, as in the case of components, for not just every breakdown or segmentation makes sense. Natural segmentation is found, for example, when a more inclusive activity contains part processes which are recognizable activities in their own right. For example, we may break down the activity of farming into subactivities among which are the "natural" units of plowing, feeding, planting, harvesting, etc. These possible phases of farming are clearly activities in their own right and not even necessarily part of the social practice of farming. These sub-activities are directly observed--they are observed _as_ plowing, harvesting,

etc, or as simple, straightforward parts of the activity of farming.

Some of the phasing (i.e., the part processes and their order of occurrence in relation to one another) may not commonly carry any descriptive-identificatory terminology, and hence may be more or less arbitrarily labelled even though the breakdown itself is not arbitrary.

During the process of analysis any phase may be at a point where it is not or cannot be broken down any further in terms of recognizable part processes or activities (the activity of eating may be such a process, and also the activity of walking--the parts of eating are themselves simply identified as eating, too). This feature of some activities is related to the notion of continuous activities, as contrasted with highly structured ones. Such continuous activities tend to be observable all at a glance--because of its repetitiveness, to see part of such an activity is, as it were, to see it all.

To repeat, what is involved in an activity analysis is the specification or articulation of the course of events that must occur in the course of the particular activity being analyzed in order for it to be that activity. There may be different levels of analysis yielding, as it were, different sets of constituents which are, however, equivalent descriptions of the same thing, namely the activity under analysis. An activity analysis may be expected to lead to an understanding of the activity that is different from our original understanding, if only in that it is more complete. This is so even though the activity was in no

discovered, for it was our knowledge of the activity that led to our analysis of it in the first place and made it possible. There is here a sense of understanding an activity or being familiar with it in a different way, which is much like understanding a geographical area better or being more familiar with it after one has made a map of the area or has studied a map of the area.

To chart the course of events amounts to saying what the order of the events must be, where order and sequence is a requirement of the activity. To describe the nature of an event is to specify the way or ways in which the relationship(s) between objects (i.e., individuals and/or components) has changed. (A component might be a set of individuals of the same kind, e.g., family persons, or equipment, or it might be a set of individuals of different kinds.) To say that some event has occurred or must occur is to say that some change in the relationship(s) between components must occur or has occurred, and that is to say that an event has occurred. For example, the event might be a change in the state of a particular individual (person or other object). This change in state would place that individual into a somewhat different relationship to other individuals in its environment.

There are many different sub-activities that qualify as part of the activity of farming and that are activities in their own right. There are many order limitations here, but there are many junctures where there is not. Because of this, there are many different varieties, as it were of the activity of farming in a way in which there are not many varieties of, say, the game, tennis.

Thus, farming is not a particularly standardized activity. Neither, however, is tennis, but here it is because of the marked lack of distinction between performance and achievement.

The primary strategy or technique employed in accomplishing an activity analysis is that of offerring a descriptive account of a paradigm case of a particular activity. Briefly, a paradigm case of a given activity is one which is clearly a case of that activity, and very often it will be a typical case. Ideally, the paradigm case is a case which has all of the logically primary features which qualify a case as a case of that particular activity, so that if any case is lacking one of those features then that case is recognized as non-paradigmatic and hence not a clear-cut instance or at least a strange instance precisely because of the way it differs from the paradigm case. To formulate a paradigm case rather than the so-called paradigm case is a bit more conservative as a descriptive stance (less commitment to specific features) but still almost as powerful descriptively, because it still fulfills the function of providing a descriptive standard.

A paradigm case formulation is a potentially powerful descriptive resource in that it provides a baseline against which other cases may be compared and by reference to which they can be described. (Generally, other cases are expressed as transformations or functions of the paradigm case.) The paradigm case can be used to enhance the precision of description by providing a framework within which one may specify how two cases of the same activity differ from one another as well as how each differs from the

paradigm case. Paradigm case formulation is particularly valuable, descriptively, in exhibiting the coherence of a range of cases which cannot be brought under a single definition or simple description (instances of "family" would be a case in point).

One might say that a successful formulation of a paradigm case activity must cite the mainly basic event requirements (and their order of occurrence) of a particular type of activity. Thus, if a particular set of events does not meet these requirements, then it is either simply not a case of the activity in question or it is a strange case because of the way it fails to meet these requirements, and the significance of that fact lies in whatever other differences hinge on (and perhaps are predictable from) this difference. The paradigm formulation might be said to be the activity that the generalized person might participate in regardless of the potential for special participation or variation on the original activity.

Another way of describing the nature of an activity analysis is to say that the analysis lays out the structural paradigm for the particular activity in question. This structural paradigm is formulated mainly in terms of component-types (e.g., objects, persons) and event-types (changes in relationship between components). Particular event-types indicate the phasing or staging of the activity. "Structural" is used here as opposed to "content". That is, the component types may be satisfied by numerous content particulars. It follows directly , then, that the event-types also are fulfilled by various particulars. For instance, if a particular event type

involves person components, then structurally there is no requirement to say which persons may occupy those activity positions, although undoubtedly the course of the activity might in certain respects be expected to reflect the participation of varying particular persons. There may be certain state and status requirements for the components which are instances of the stated component type, e.g., the food component must be in a state of unpreparedness, or the person component must be in a state of hunger.

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13. ABSTRACT

Evaluation of automatic indexing and retrieval effectiveness of the Classification Space and the Attribute Space procedures was carried out with a set of actual users and requests. A "rule-following model" of language and behavior was presented as a basis for an integrated program of research and development in linguistic data processing. Three feasibility studies directed toward the technical implementation of Means-Ends, Process-Activity, and Part-Whole concepts as information formats were performed.

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